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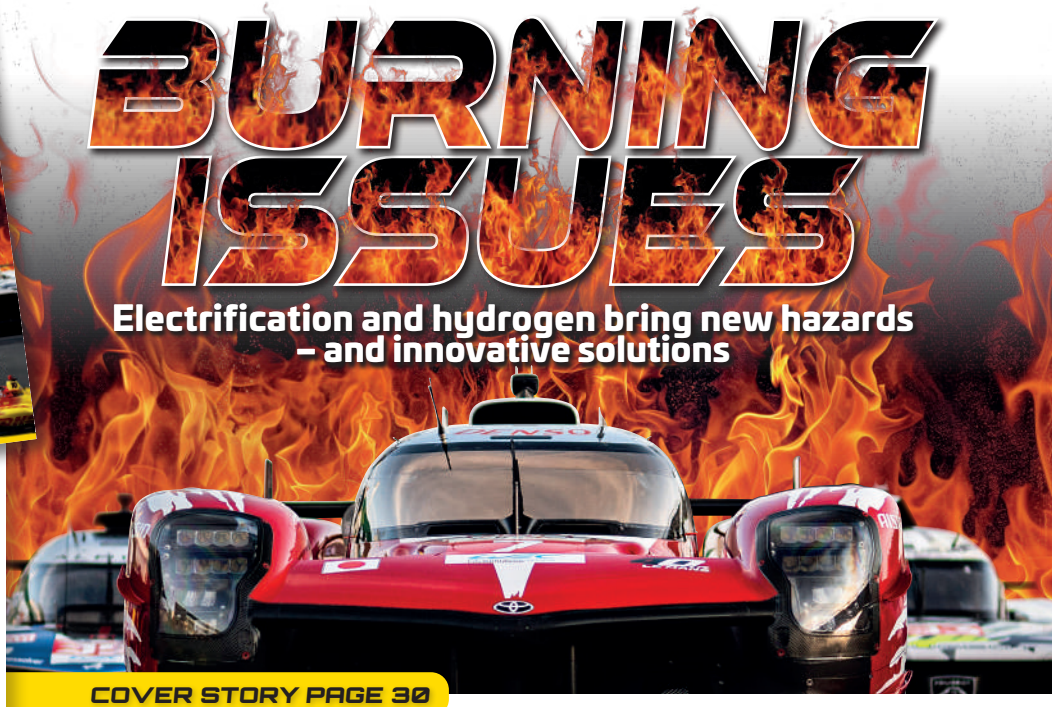

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MOTORSPORT IS SLEEPWALKING INTO A SAFETY CRISIS

MOTORSPORT prides itself on being the proving ground for future road technologies. Yet as we rush headlong into alternative powertrains – electric, hydrogen, or whatever comes next – are we ignoring a truth that should terrify us? These systems introduce safety risks we are not properly prepared for.

Battery-electric cars don't behave like anything marshals or rescue crews have faced before. A ruptured fuel tank was dramatic, visible, and usually immediate. But a damaged battery pack can smoulder unseen, only to erupt hours later in a toxic inferno. Even experts admit we don't yet fully understand the long-term behaviour of thermal runaway events.

Hydrogen isn't a magic solution either. Its storage pressures push materials to their limits, and when it leaks, the flame can be nearly invisible in daylight. Imagine a driver trapped in wreckage, surrounded by rescuers who cannot even see the fire they're walking into. This isn't science fiction – it's physics.

And yet, too often, the conversation is dominated by sustainability slogans and marketing spin. Do we really think we are devoting the same investment and urgency to the safety quest as we are to shaving tenths off lap times?

Our cover feature this month is a must-read interview with Jim Morris, managing director of Lifeline Fire & Safety Systems. Familiar to most in motorsport, Jim's company is currently fighting on this new frontier we have opened. It possesses one of the few facilities in the UK designed specifically to explore the characteristics of battery fires. It is also in the process of validating an explosion-suppression technology for the UK Ministry of Defence, which could potentially be adapted for hydrogen applications in motorsport.

Jim's revelations, regarding both thermal runaway and hydrogen safety, certainly focus the mind. And I suspect we would be horrified if we witnessed some of the discoveries thrown up by Lifeline's R&D work.

None of this should dissuade motorsport from embracing new propulsion technologies. In fact, racing is the perfect laboratory to stress-test these systems before they reach mass-market road vehicles. But just as the FIA once had to learn the hard lessons of refuelling fires, tyre explosions, and cockpit intrusion, we must now invest in research, simulation, and rigorous training to prepare for electric and hydrogen risks.

My fear is that the technology, as ever, is one step ahead of the standards and procedures we are working frantically hard to put in place.

Motorsport has had its warnings: the battery fire at Lydden Hill destroyed two cars, the transporter, and ended the World RX meeting prematurely, but also decimated the 2023 world championship calendar. Its shockwaves didn't end there, for they contributed to the end of the much-vaunted hybrid system in the World Rally Championship too.

We need to heed those warnings. If motorsport doesn't get serious, the first major accident involving these technologies will be a wake-up call written in headlines we cannot afford. Racing should lead innovation – but leadership means addressing dangers before they become disasters.

Mark Skewis
EDITOR

"On a 1 to 10 scale, it's a 10!"

Could deal signal boom-time for IndyCar as FOX takes stake in Penske Entertainment? By **Mark Skewis**

WITHOUT Roger Penske's purchase of the series and the Indianapolis Motor Speedway, IndyCar could well have become just another victim of the COVID-19 pandemic.

His leadership and financial sacrifice kept the series alive, offering the kind of long-term stability it desperately needed. Yet, fast-forward a few seasons and the unthinkable was happening: previously loyal team owners were starting to question The Captain's perceived lack of investment.

Faced with NASCAR's success and Formula 1's inroads into the American market, IndyCar was crying out for fresh momentum. Penske's stewardship – while steady –was failing to push the series into genuine growth. There were even calls for him to sell...

Then, with a single announcement, the game changed: FOX Corporation confirmed it was buying a one-third stake in Penske Entertainment, the parent company of both the NTT IndyCar Series and the Indianapolis Motor Speedway.

It is not just another media rights deal. FOX has gone from broadcaster to *shareholder*, from covering the sport to actively shaping its future. The move sets up what could be the most consequential corporate partnership in IndyCar since Tony George's formation of the IRL three decades ago.

The buy-in – estimated by *The Wall Street Journal* at $125–135 million – comes against a backdrop of growing disquiet. Rising technical costs, particularly with the new hybrid units, had left team bosses questioning when and how Penske would inject more capital. The FOX deal appears to answer that call, albeit in an unexpected form: not Penske alone spending more, but a media giant placing skin in the game.

What does FOX bring?

In its first year as exclusive broadcaster, FOX already proved it could deliver eyeballs. The 2025 Indy 500 drew 7.01 million viewers, the highest in nearly two decades. Season-long numbers were up 31% year-over-year. With equity on the line, FOX now has a direct reason to pump more promotional muscle into the product.

A hyper-engaged digital strategy and immersive content focus is promised, with enhanced promotion and star-building opportunities for NTT IndyCar

BELOW IndyCar's Grand Prix of Arlington, a first-of-its-kind joint venture between Penske Entertainment, the Dallas Cowboys and the Texas Rangers, is seen as a pointer to the way ahead

All images: Penske Entertainment

Series drivers. Expect FOX to lean into technical storytelling – augmented reality, drone shots, and live data overlays designed to highlight IndyCar's speed and complexity.

With a seat at the ownership table, FOX could help bankroll marquee projects. Insiders point to the upcoming 2026 Arlington street race – a collaboration with the Dallas Cowboys and Texas Rangers – as a signpost for where future investment might go. Bigger events, bigger purses, and more polished fan experiences are suddenly on the table.

Team owners, who have long felt caught between ballooning budgets and flatlined revenues, view the move with cautious optimism. Michael Andretti and Zak Brown were among those who had previously pressed Penske for "outside capital" to keep pace with F1 and WEC's booming profiles. Now that outside capital has arrived.

The sentiment in the paddock is relief, but also vigilance. "It's encouraging," said one senior team figure off-record. "But what matters is whether that money finds its way into prize funds, cost support, and marketing. Otherwise it's just moving numbers on paper."

ABOVE The deal includes a multi-year extension of IndyCar's media rights with FOX Sports

What they said

Brad Hollinger, co-owner of Juncos Hollinger Racing, was in the welcoming camp. "I think it's outstanding, for every reason," he said. "It will expand the viewership and the sponsorship in the sport tremendously, because FOX have an incredibly innovative organization.

"They know everything there is to know about putting on live entertainment and going beyond racing cars. We really have the opportunity for year-round content to really get the younger generation involved, show things behind the scenes, raise and elevate the status of the drivers, which I think is terrific. And then their engaging digital strategy and content focus will be outstanding. There's no question. On a 1 to 10 scale, it's a 10. And I know that I'm not alone in that."

IndyCar team owner Chip Ganassi said of the agreement: "you know what it does? It brings 'entertainment' to Penske Entertainment!"

"We're thrilled to join the IndyCar ownership group at such a pivotal time for the sport," said Eric Shanks, CEO & Executive Producer, FOX Sports. "IndyCar represents everything we value in live sports – passionate fans, iconic venues, elite competition and year-round storytelling potential. This investment underscores our commitment to motorsports and our belief in IndyCar's continued growth on and off the track. We're excited to help elevate the sport to new heights across all platforms."

The deal also has wider implications. With Disney/ESPN and Warner Bros. Discovery exploring similar moves in other sports, IndyCar may become the test case for a new model of media-league co-ownership. If FOX can help transform IndyCar into a stronger, more profitable property, other series may follow suit.

Pivot point

IndyCar's new FOX partnership is more than a commercial transaction – it is a pivot point. Owners had started to fear stagnation. Instead, they now face a future where the series' broadcaster has a vested interest in every full-grandstand shot and every bump in TV ratings.

For Roger Penske, it means relief from constant calls for deeper pockets. For FOX, it is a high-risk play to prove that motorsport can still grow in America's crowded sports landscape. And for the paddock, it's a moment of rare alignment: if FOX wins, IndyCar wins.

The next test is simple – will fans and teams feel the impact on the ground, in budgets, and at the turnstiles? If so, July 31, 2025 may go down as the day that the wounds from 'The Big Split' – a power struggle which devastated the popularity of open-wheel racing in the US, and from which TV viewership has struggled to recover ever since – finally healed.

How FIA's new steering damper improved Formula E shunt safety

FIA/Formula E

THE FIA has revealed how its behind-the-scenes work on the development of a steering wheel damper has helped end a spate of hand injuries in Formula E.

Accidents for the likes of Envision Racing's Robin Frijns and NEOM McLaren's Sam Bird triggered an FIA investigation into exactly what was to blame.

The process of engineering an eventual solution involved a painstaking procedure from testing and simulation to final validation with FIA Safety Director Nuno Costa, FIA Chief Technical and Safety Officer Xavier Mestelan Pinon and ABB FIA Formula E World Championship Medical Delegate Bruno Franceschini playing key roles.

"I realised that we have these hand fractures which are not usual," said Franceschini. "I know the drivers very well and I had feedback from them and looking at what they are saying to me, and the feeling they have in the car, I spoke with the [FIA's] safety department, telling them there is something to do."

It transpired that the front-end shunts caused the steering wheel to rotate up to 10 times faster than usual. This discovery prompted a suite of solutions from modifying the steering wheel's shape to adding foam inside the cockpit and redesigning the front wing to better protect the car's front wheels.

While all of those adaptations have unquestionably helped, the real breakthrough came in the form of a new steering damper, which was introduced for the recent 2024-25 campaign. The damper absorbs the energy of the impact and reduces the peak rotational speed in such situations by as much as 40 per cent, with no repeat injuries since its introduction.

Dissipates force

"Basically, I broke my hand inside the cockpit because I wasn't expecting the steering wheel to suddenly come out of my hands," said Frijns. "Unfortunately, I had quite some damage because I broke the bone in three places.

"My injury was quite bad, but the FIA is pushing hard to make it safer for us and they've made big steps from that moment onwards. I think the steering damper is a very good tool. If you have a crash, the damper takes all the force away from the wheel so it doesn't really move out of your hands anymore." RT

ABOVE Drivers had suffered a number of hand injuries from contact on-track during the Gen3 era

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NASCAR steps up bid to keep cars grounded

NASCAR has added new A-post flaps to its Cup Series race cars, implemented from Daytona last month, to help keep cars grounded during drafting and prevent flips.

The flaps are designed to mitigate the lift that can cause cars to go airborne, especially during high-speed drafting. They are expected to increase the chances of a car staying on the ground in a 90-degree spin by 40 to 50%.

The addition of these flaps – which will self-deploy during sudden yaw or lift – is a direct response to multiple massive flips at Daytona International Speedway and Talladega Superspeedway over the last few seasons.

Ford driver Ryan Preece has a particularly spectacular record for going airborne at superspeedways. Twice at Daytona, his No. 60 Mustang Dark Horse has been involved in bizarre flips: once in 2023 when it pirouetted mid-air, and again this year when it reared onto two wheels before toppling onto its side in Turn 3.

Tested in the GM wind tunnel in February, the new flaps hit the track for the first time when three Cup Series teams participated in a recent Goodyear tyre test at Michigan.

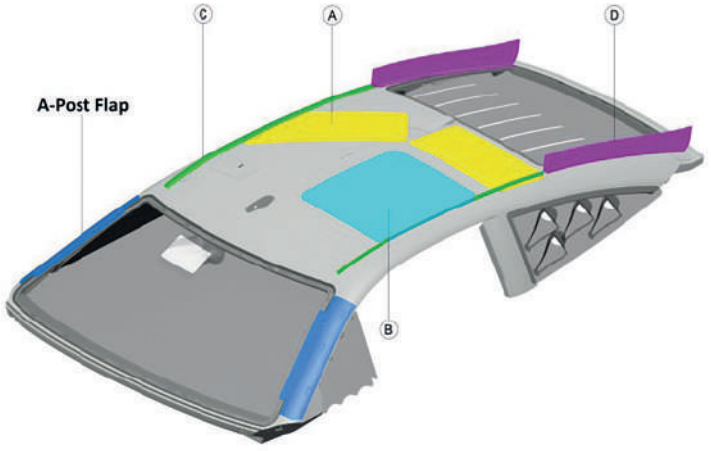
"It started out as a concept that wasn't really viable, and then we had a couple of brainstorms and sort of came up with this idea," explained Dr Eric Jacuzzi, NASCAR's vice president of vehicle performance innovation aero. "It proved to be very, very effective."

By adding the extra flap, the goal is to decrease lift in the early part of the spin and ultimately reduce the amount of airborne crashes.

"We think that the less lift that we can have on the car early in the spin, that's more tyre contact with the ground, more slowing it down, which is all good for us," Jacuzzi said.

The new flaps are kept in place by magnets and are connected to the existing roof flaps. If a roof flap deploys, the cable will pull the corresponding A-pillar flap open.

NASCAR expects the flaps to disrupt airflow and reduce lift when deployed, reducing the risk of cars flipping during drafting situations. They will not, however, impact speed or drafting ability.



BELOW Ryan Preece's flip at Daytona earlier in the season (below) was one of the catalysts for the new flaps (right)

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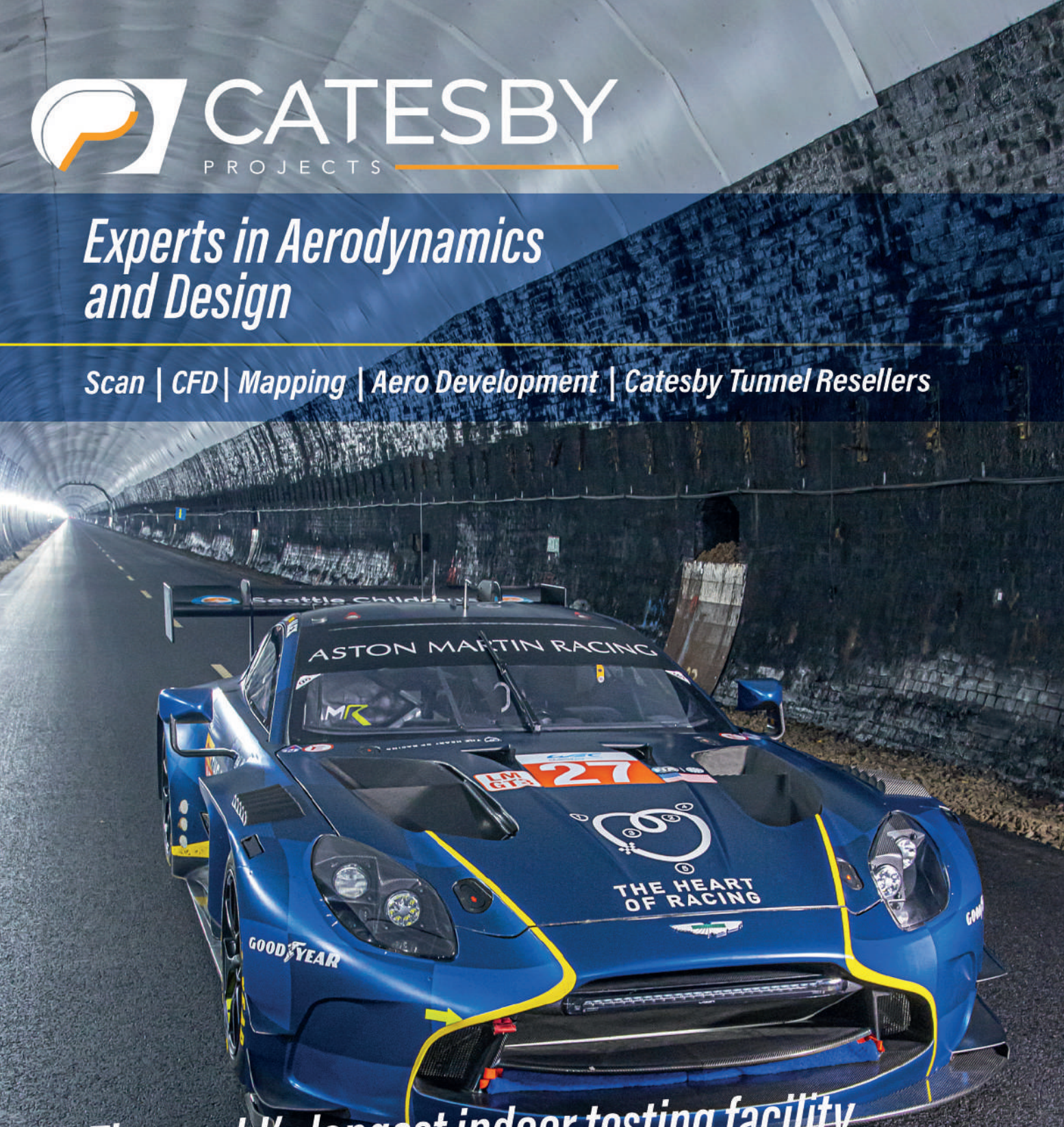

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Chris Mark Raschke

June 19, 1964 – August 3, 2025

THE motorsport community is mourning the loss of Chris Raschke, killed in an accident at the Bonneville Salt Flats last month.

Raschke was driving Speed Demon III, the latest iteration of the team's vehicle. The Speed Demon team said in a statement that it was "deeply devastated" by his death.

CHRIS was born on June 19, 1964, at Community Memorial Hospital in Ventura, California, to Vernon and Alice Raschke. He called Ventura home for all of his 61 years, and will be deeply missed by his community and all who knew him.

An avid lover of engines and speed, Chris embraced the thrill of racing. At 16, he began working at Ventura Raceway as their first official employee. He raced ATC three-wheelers and his Ford Pinto in the mini stock division with his cousin Mike Raschke at the racetrack. He then began working at Duttweiler Automotive in 1983, working at the side of master engine builder Kenny Duttweiler. He became deeply involved in working on and maintaining engines in race cars, as well as race boats.

In 1996, he was hired at Automotive Racing Products and became the Director of Sales and New Products. In the scope of his duties at ARP, he interfaced with engine builders, engineers, designers and competitors all over the world. He was very much hands-on and had a remarkable ability to look at an assembly or a design from a practical point of view and offer suggestions to improve it.

He was very much trusted and respected for his depth of knowledge and experience in the industry. Chris was always ready to jump in and help anyone in need of parts, instructions and assistance. He got to know so many new people through his job, but also remained friends with them due to his upbeat personality, his positive "will-find-a-way" attitude and love of the sport.

All ARP employees are in shock at the news of his passing and there is a noticeable void at all the ARP manufacturing shops. For Chris, working at ARP was not just a job – it was something he truly loved doing.

Chris became enamoured with Land Speed Racing a few decades ago through his friendship with Steve Watt, who built the fabled Speed Demon II streamliner. The streamliner was owned and driven by the late George Poteet and he subsequently became part of the dedicated crew. He also aspired to drive, getting his racing licence driving the popular White Goose Bar Modified Roadster. He earned his popular red hat (given by the SCTA for setting a record in excess of 200 mph) driving the Dodge Ram pickup owned by his close friend, Wayne Jesel. Chris was seldom seen without his treasured headwear, which he proudly carried with him everywhere he went.

In 2024, Chris, Wayne and a team of three friends won the SCTA points championship based on the year's record-setting performances at the historic El Mirage dry lake. When George Poteet opted to retire from driving the Speed Demon in 2023, he named Chris as his replacement. Chris would go on to set the B/BFS record at 459.734 mph and also earn the prestigious Hot Rod Magazine trophy for the fastest time of the meet – the 12th time the team had won it. The feat also earned Chris his famous black hat from the SCTA for setting a record in excess of 400 mph.

Chris certainly had a passion for racing, but his greatest passion was for his wife, family and close friends – whether it was a weekend at the lake, barbecuing at home, or exploring new places together. Nothing made him happier than teaming up with his kids for a "Record Run", where they'd change a water heater, mow the lawn, change oil, or track down a mystery noise under the hood.

He was one-of-a-kind, a special person, with a generous heart and kind spirit. He is survived by his wife, Connie, and children, Kenneth, Kristoph, Carley, Brooke (Chris) and Kiley, as well as grandkids Colt, Piper and Renley.

Known for his tireless work ethic and dedication, Chris had a rare gift for making others feel seen and valued. Yet, it was his radiant smile, quick wit and warm spirit that truly set him apart. He listened more than he spoke, offering words of wisdom when they were needed most. His positivity was contagious and had an uncanny way of lifting spirits wherever he went.

A special scholarship is to be established in Chris Raschke's name by SEMA. This new scholarship will ensure that his legacy continues by providing opportunities for students who share his passion in performance, engineering and excellence. RT

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Gibson reunites with NISMO for new LMP2 powertrain

GIBSON Technology is partnering with NISMO, Bosch and Xtrac for the next-generation LMP2 powertrain, which will underpin the popular category from 2028 to 2032.

The UK-based company, which was awarded the next-gen supplier contract in June, will design and develop the new unit in collaboration with Nissan/NISMO. The new LMP2 cars will be powered by a bespoke 3.4-litre, twin-turbocharged V6, featuring direct fuel injection.

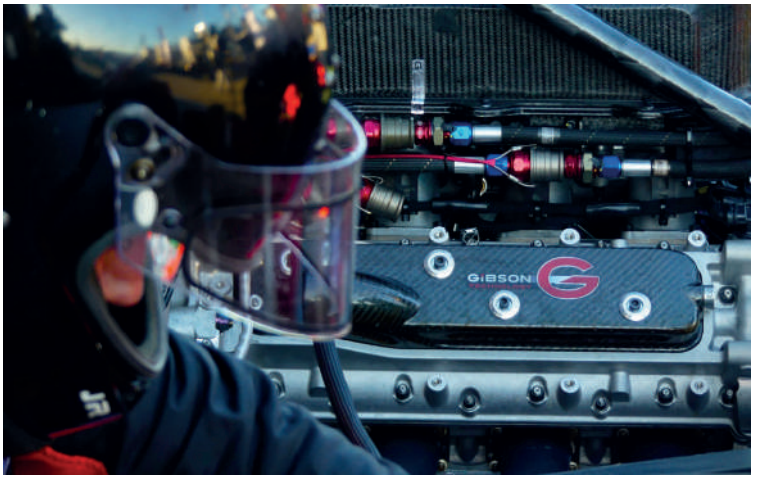
The project reunites Gibson with NISMO, Nissan's motorsport arm, bringing the latter back to LMP2 competition for the first time since 2016. Originally designed for the SUPER GT series, its 4.5-litre VK45DE V8 engine was modified for LMP2 through a partnership with Gibson that became the benchmark for the category, going unbeaten for four seasons with a remarkable 35 consecutive FIA WEC victories in a row.

The shift to a turbocharged V6 platform signals the beginning of a new era for Gibson. It has produced a naturally aspirated V8 for LMP2 since becoming the spec engine supplier back in 2017 with its 4.2-litre GK428. Prior to that it was the engine builder for the Nissan VK45DE back to 2011 and its own branded V8s back to the start of the class in 2004.

Bosch Motorsport has also been brought onboard to provide the electronic architecture for the powertrain. The German firm will supply the ECU, powerbox, wiring harness and a new steering wheel developed by MoTeC, a Bosch subsidiary.

Xtrac will handle the transmission side of the programme. It currently supplies gearboxes for ORECA's 07 – the go-to car in LMP2 – but will develop a new bespoke transverse gearbox complete with bellhousing and a gearshift system for the upcoming LMP2 platform.

"We are incredibly proud to be working alongside our technical partners for the development and delivery of the new LMP2 powertrain system," said Gibson Technology managing director Mark Brittan. "This exciting project promises to deliver fantastic performance, while ensuring costs are kept under control and supply is reliable." RT



BELOW Gibson starts a new LMP2 era

Extreme H partners with FOX for next-generation suspension package

EXTREME H, the world's first hydrogen-powered racing series, has signed a multi-year deal with Fox Factory Inc. (FOX) to become its Official Suspension Partner. The agreement builds on FOX's experience in Extreme E, where the US-based company has been supplying hardware since the championship's inception.

All Pioneer 25 cars – the hydrogen-powered successor to Extreme E's Spark Odyssey – will run a new FOX suspension package designed specifically for the series' harsh and varied off-road conditions. Developed through three years of collaboration, the system introduces several upgrades over the outgoing setup, including a coil-over and external bypass damper configuration on all four corners. Each car will run eight dampers in total, with new 3.0" bypass units replacing the smaller 2.5" rear dampers from Extreme E. Wheel travel has also been increased by around 70 mm, while a secondary front bypass damper has been added to further improve control.

ABOVE Each car will run eight dampers in total

FOX engineers will attend every event to provide set-up support, diagnostics, and shock servicing. "Extreme H gives us the opportunity to work alongside world-class racers and teams who are shaping the future of motorsport," said Bobby Smith, FOX's Director of Motorsports. "As the automotive industry evolves toward electrification and hydrogen, we're excited to be part of this transition."

Extreme H will debut later this year, becoming the first hydrogen racing championship. RT

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Honda celebrates record-breaking IndyCar season

HONDA and Honda Racing Corporation USA are celebrating a record haul of victories in an IndyCar campaign.

Honda swept the manufacturers', drivers' and Rookie of the Year NTT IndyCar Series championship titles in a dominant season where its drivers won 12 of the first 15 races. It also scooped 'the big one', winning the most coveted jewel in the crown: the Indianapolis 500.

This was the first time Honda had triumphed in the manufacturers' title chase since 2021. Those wins came on all four primary track types the IndyCar series races on: road courses (Thermal, Barber, Indy GP, Road America, The Honda Indy 200 at Mid-Ohio, Laguna Seca); street circuits (St Petersburg, The Acura Grand Prix of Long Beach, Detroit); short ovals (World Wide Technology Raceway, Iowa Speedway); and speedways – where Honda scored its 16th Indianapolis 500 victory.

While it has been a season largely dominated by Alex Palou and Chip Ganassi Racing, Honda squads Andretti Global, Meyer Shank Racing and Rahal Letterman Lanigan all contributed with victories.

Twelve wins in a single season is a record for Honda in the current generation of NTT IndyCar Series competition. It surpassed Honda's tally of 11 wins, set in 2018, and equals Chevrolet's achievements in 2014 and 2015.

"What an amazing season," reflected David Salters (President, Honda Racing Corporation USA). "The greatest achievement in a sporting series is to dominate, it happens rarely. Thanks to the challenging spirit of our Honda Racing associates, we dominated."

When quizzed for the secret of that domination, Salters replied: "A racing car is a sum of the parts. It's never one thing. It's a collection of everything, in my experience. I've only been doing it for 30 years, so I'm still learning a lot.

"We weren't happy where we were last year, so we worked really, really hard over the winter. It's like a duck. It looks really calm on top. There's lots of flapping underneath!

"There's this ferocious amount of work that happens from people who are hugely motivated to succeed. We're racers. To watch people achieve what they achieved through being smart and working hard is the greatest privilege we can have.

"So I think there's not one thing, but there's a collection of things. CGR is performing at huge heights. All the boys and girls, HRC we've stepped up to huge heights. Alex Palou, we are witnessing a generational talent and it's a pleasure and a privilege to watch him behind the wheel.

ABOVE & BELOW
Palou's fourth title moves him equal with Dario Franchitti, Sebastien Bourdais and Mario Andretti

"So it's all these things that go together. Fundamentally, just a huge amount of hard work. We will pat each other on the back, hug, and enjoy the moment, then re-group and back to work."

This was the first full season for IndyCar's supercapacitor-based hybrid system, and Salters acknowledged that the company's simulation capabilities had played a role in its success.

"The more you understand, the luckier you get," he stressed. "We do a huge amount of simulation to try to understand how to use the hybrid system in terms of lap time, deployment. Also understanding driver workload, what can the driver actually do. They're pretty busy when they're doing 240 miles an hour on an oval.

"We did a huge amount of simulation with the teams and tried to understand the best way to use the hybrid system, then validate it in reality. Simulation is a simulation. It has a lot of assumptions. Sometimes it can be right, sometimes it can be wrong.

"Basically the bedrock of that is vehicle simulation, whether it's lap time simulation or in the DIL. We have a very, very good DIL that we developed. We use our tools to help understand that." RT

Lamborghini shelves LMDh as in-house GT3 takes priority

LAMBORGHINI will withdraw its SC63 LMDh from competition at the end of 2025, pausing its prototype ambitions to concentrate fully on its new in-house GT3 and Super Trofeo platforms.

The SC63, built around a Ligier chassis and powered by Lamborghini's bespoke 3.8-litre twin-turbo V8 coupled with the spec hybrid unit from Bosch, WAE Technologies and Xtrac, represented the marque's first foray into top-tier endurance racing. Despite significant investment, the car has struggled to deliver the performance needed to challenge established rivals. A major testing accident at Paul Ricard in 2023 disrupted its initial development, while balancing the dual IMSA and WEC programmes stretched resources.

LAT Images/IMSA

BELOW The SC63 is the first casualty of a golden LMDh era

The car's aero platform was reported to require a fundamental overhaul, with updates planned for 2026 to address stability and drag-to-downforce efficiency. Those plans have now been cancelled.

"As the project developed, resource demands – both in terms of budget and technical complexity – have grown beyond original projections," Lamborghini said in a statement.

For 2025, the SC63 has run in IMSA's Endurance Cup under Riley, but a string of reliability issues, including retirements at Daytona and Sebring, underlined the scale of the task. A seventh place at Watkins Glen remains its best result to date.

Attention now shifts to Lamborghini Squadra Corse's first fully in-house designs: the Temerario GT3 and its one-make Super Trofeo counterpart. The Temerario GT3, revealed at Goodwood in July, is undergoing intensive testing across Europe ahead of its competitive debut at the 2026 Sebring 12 Hours. Its target is clear: to surpass the Huracán GT3, a car that amassed 192 victories and 96 titles worldwide.

The Temerario Super Trofeo will follow later in 2025, ensuring Lamborghini's customer racing ladder remains intact as the brand pauses prototype ambitions. RT

Genesis GMR-001 Hypercar completes shakedown

GENESIS Magma Racing's new GMR-001 Hypercar has turned its first laps at Paul Ricard, marking the official start of an intensive development programme ahead of the Korean manufacturer's FIA World Endurance Championship debut in 2026.

The car, built around an ORECA-developed LMDh chassis and fitted with Genesis' own powertrain, was handed over to the newly established team base at Le Castellet in early August. Following the successful installation of its hybrid system, gearbox and combustion engine, the prototype was rolled out on the circuit's training track in a "bare carbon" shakedown run.

Brazilian endurance star Pipo Derani completed the initial laps before handing over to team-mate André Lotterer. Both had already completed extensive simulator work to validate the GMR-001's baseline set-up.

"Every bit of running we do with the GMR-001 in 2025 is extremely valuable," said Technical Director François-Xavier Demaison. "The simulator preparation means we have a good starting point for the first tests."

Team Principal Cyril Abiteboul described the rollout as "a hugely important moment" for the project: "After planning for and talking about these moments for the past eight months, to be able to see a finished car running exactly as we intended is incredibly exciting."

The GMR-001 is the first of three development chassis scheduled to be delivered by ORECA. Genesis Magma Racing will now embark on a European test programme to fine-tune systems integration and aero efficiency ahead of homologation. Parallel to the Hypercar work, the team continues to operate an ORECA 07 LMP2 in the European Le Mans Series with IDEC Sport, providing valuable operational training for staff.

Genesis remains on schedule with its ambitious timeline, with a two-car Hypercar entry due to debut at the 2026 Qatar 1812km season-opener. RT

LEFT Genesis Magma Racing's first prototype completed a successful rollout at Paul Ricard

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President of Honda Racing Corporation USA (HRC US)

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"Another great learning experience for the two of us that attended from NASCAR. The topics were very relevant to the future of motorsport, and challenged us to look deeper into some areas of development that we had not previously considered or perhaps considered seriously enough. As always, the collegial atmosphere and lively debates and conversations make for a great event. I am looking forward to seeing everyone again next year and hearing about the advancements another year brings"

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RALLYING TO THE HYDROGEN CAUSE

Toyota believes hydrogen could save the internal combustion engine – and has put its money where its mouth is. **Chris Pickering** reports on the GR Yaris Rally2 H2 Concept demonstrated in Finland

YOU have to hand it to Toyota. While others have sat back and debated the future of motorsport, the Japanese giant has pushed ahead with a series of hydrogen-fuelled technology demonstrators, both in endurance racing and rallying.

The latest to grace the stage is this, the Toyota GR Yaris Rally2 H2 Concept. Based on Toyota's successful Yaris Rally2 machine, it was developed by the Toyota GAZOO Racing World Rally Team (TGR-WRT). Fittingly, the H2 Concept's debut came at the recent Rally Finland, just a few kilometres from TGR-WRT's headquarters in Jyväskylä. At the wheel was none other than Juha Kankkunen, who began his illustrious World Rally Championship (WRC) driving career with Toyota and now works as the team's deputy principal.

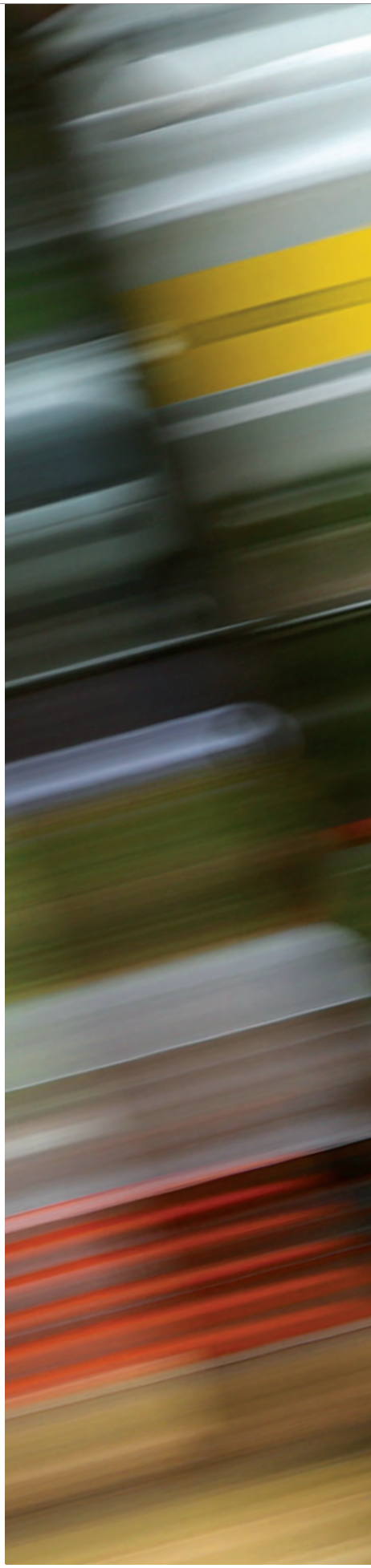
The outfit in Jyväskylä has been developing Toyota's Rally1 and Rally2 cars since 2015 – initially under the leadership of another Flying Finn with longstanding links to the brand, Tommi Mäkinen. Not long afterwards, the parent company in Japan began experimenting with hydrogen-fuelled cars in the Super Taikyu Series, where it has contested the Fuji 24 Hours race five times with various iterations of the GR Corolla H2 Concept.

The two projects began to intertwine in 2022, when Toyota ran a GR Yaris converted to hydrogen combustion as a course car on the Ypres Rally. That car was essentially a production GR Yaris fitted with the hydrogen fuel technology from the GR Corolla H2 Concept, which uses the same 3-cylinder G16E-GTS unit as its base engine. The new Rally2 H2 Concept features a further development of that engine, but crucially, the chassis is now built to full Rally2 specification.

"The chassis is 100 per cent Rally2. It has the proper performance package, including the correct suspension with more than 320 mm of wheel travel, custom dampers and fully adjustable geometry, along with the correct safety equipment, the roll cage and chassis modifications. We could take that car and run it as a rally car on any terrain from Finland to Kenya," notes TGR-WRT technical director, Tom Fowler.

> *"The noise, the feel and the sensation of the engine are just like driving the gasoline car"*

"But the powertrain technology has been developed in conjunction with the Toyota Motor Corporation (TMC) to integrate all the learning ▶



BELOW "Someone told me I had been fastest seven times on this stage," reported Juha Kankkunen of his run through the Harju test in Jyväskylä. "And I was fastest again – in the hydrogen class!"

Photos: TGR-WRT

development has been around how to get that mixture into the right condition, combust it correctly, and then get it out again. Obviously, that's similar in principle to a gasoline engine, but when you change the fuel, you introduce some different requirements."

Toyota began its hydrogen motorsport experiments in Japan with gaseous hydrogen. However, for long-distance endurance races, the Corolla switched to groundbreaking liquid storage in 2023. For the rally concept, TGR-WRT has reverted to gaseous storage at 700 bar.

For packaging reasons, the fuel is split into two tanks. Part of the reason for this at that gaseous hydrogen needs to be stored in a pressure vessel, which makes it significantly harder to design the shape around other objects inside the safety cage. Another practical consideration was that Toyota had a range of tanks available from other projects and this

that they've built up over the last few years in hydrogen technology. That includes not only the engine itself, but of course, the fuel tanks and all the safety equipment."

Unlike the spaceframe-based Rally1 machines, the cars in the second tier Rally2 category – used in the WRC2 and various regional championships – are still based on a production chassis. The Yaris Rally2 is unique in being based on a four-wheel drive road car, while others are modified from a front-wheel drive platform, but all must retain substantial portions of the production shell.

Like the standard Yaris Rally2, the H2 Concept can trace its origins back to the 3-cylinder turbocharged road car, but it's a very different unit in hydrogen form, says Fowler.

"I think the best way to describe it is a hybrid [of the Rally2 engine and that found in the Super Taikyu Corolla]," he comments. "The base engine is a production unit from TMC that starts off as a direct-injection gasoline design. For Rally2, we have to use certain elements of that production design. But for the hydrogen projects, TMC has had to modify various aspects of the fuel system and the internals. So, it's a mixture of both projects, but the end result is effectively a new engine."

Parity with gasoline

The exact details of the engine modifications have been kept under wraps. Fowler hints that the fuel system was the only hardware change initially required to get the engine to run on hydrogen, but further modifications have followed to bring the performance and reliability up to Toyota's targets. That includes achieving "at least the same performance level" as the gasoline engine, we're told.

"The way fuel/air mixture is formed inside of the inlet tract and the cylinder is different on a hydrogen engine to a gasoline engine, where you're dealing with liquid fuel," he explains. "Most of the adaptation and the

RIGHT Wary of safety considerations, TGR-WRT has reverted to gaseous storage for the rally concept, incurring a weight penalty in the process

LEFT Top Gear's Richard Hammond was one of Kankkunen's passengers. "The ICE is the most important thing we have," he enthused. "We don't want to let it go"

RIGHT The H2 Concept uses a bespoke cage, which increases the volume of the safety zone inside the car

configuration allowed an existing tank design to be carried over.

"The Rally2 car has a safety cell within the original body shell, so that eats into the usable volume inside the car," comments Fowler. "It's a principle of all FIA rally cars that the gasoline fuel tank is protected by the same safety system as the occupants. So, when you change the size or the shape of the fuel tank to move from a gasoline to a hydrogen version, you still have essentially the same requirements from the safety system, which makes the packaging very difficult. As a result, the H2 Concept uses a bespoke cage, which increases the volume of the safety zone inside the car."

TGR-WRT's target was to package enough hydrogen inside the car to complete a ▶

Toyota

typical WRC stage, Fowler explains. "A WRC stage is generally 25 km or less," he comments. "That's possible [with the current setup]."

In theory, then, Toyota is already a significant portion of the way to building a viable hydrogen rally car. However, there is still some distance left to go. While sub-25 km is common, some modern WRC stages have stretched up to the 80 km limit imposed by the championship. On top of that, the cars sometimes need to travel more than 200 km on the road from one special stage to the next.

Even with some tweaks to the sporting format, it seems likely that a competitive rally car would need to carry more hydrogen than the current concept. The obvious solution would be to switch to liquid storage – already used in the Super Taikyu Corolla and Toyota's recently unveiled Le Mans Hypercar testbed, the GR LH2 Racing Concept.

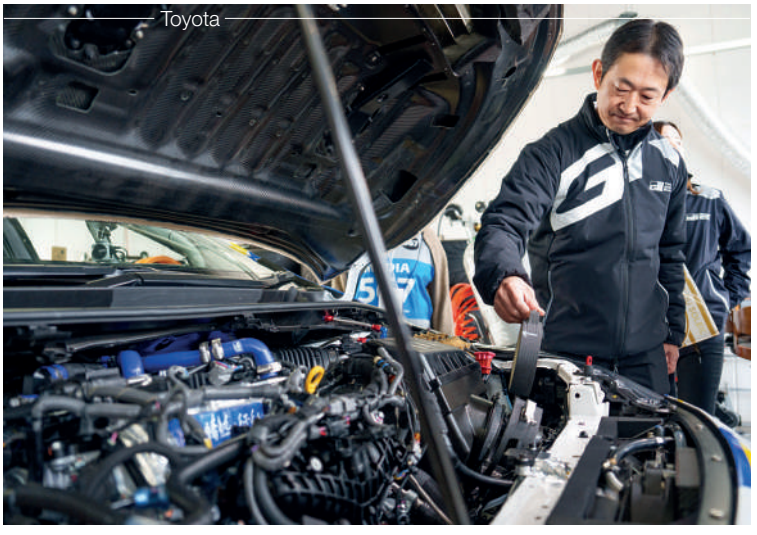
Clear brief

"[Liquid hydrogen] is certainly the direction that TMC has been heading in with the Corolla racecar project, but that's not something we've looked at yet with the rally project," comments Fowler. "We had a very clear brief about what to do for this first project, which was to bring hydrogen technology into the world of rallying, which has its own challenges.

"Aside from the engine and the fuel system, you have the challenge that the Yaris Rally2 is not that big. It has all the normal safety equipment of a rally car [designed to accommodate a co-driver as well as the driver] and it has a complete four-wheel drive system in place. So, there's a lot of packaging challenges just in creating this first vision. That's why it was decided to use a system which was very well known, so that we could concentrate on solving all those rally-based challenges first and then develop something different later on."

ABOVE & BELOW The 1.6-litre three-cylinder engine builds on the manufacturer's learnings in the Super Taikyu series in Japan

> *"There's a lot of packaging challenges in creating this first vision"*


Toyota

One of the challenges that Fowler is referring to is the environmental extremes encountered in rallying. The temperature can fall to -30 deg C on the Arctic Rally in Lapland, whereas upwards of +40 deg C is increasingly common on warmer events in places like Greece and Mexico.

"We have a huge band of temperatures to deal with," notes Fowler. "There are also major variations in altitude; we've had a stage in Jordan in the past that was actually run below sea level, whereas in Argentina we can be competing at 2,700 metres. On top of that, a rally car needs to be driven on snow, tarmac and gravel, with rough surfaces and jumps. We know very precisely what our Rally1 and Rally2 cars can do under those conditions.

"One of the main reasons this car exists is to understand what the limitations are when you put the hydrogen fuel system into those environments. The aim is to find solutions to those challenges where we can, and to understand the constraints that apply to the car elsewhere. At this stage, we're just concentrating on our local environment in Finland, which is very much in the middle range of all those extremes. We've only driven in summer conditions so far, for example, but the process is ongoing."

Feedback from the drivers so far is said to have been good, and the Yaris's charismatic three-cylinder warble bodes well for spectators.

"Noise is a really important topic," admits Fowler. "Actually, it's one of the reasons why this whole thing came about. [TMC chairman] Akio Toyoda has been very clear to us through all the decision making we've made with the FIA about Rally1, Rally2 and the future of the sport in general, that the noise of the engine coming through the forests is a huge part of the appeal. So, a lot of the driving force is to keep those emotions.

"The feedback from the drivers on that side is that there's essentially no difference – the noise, the feel and the sensation of the engine are just like driving the gasoline car. In terms of the performance level, it's already very close to the existing Rally2 car. There's some slight weight penalty overall with the car, most of which comes from being very sure on the safety side, but it's not far off."

Alternative powertrains

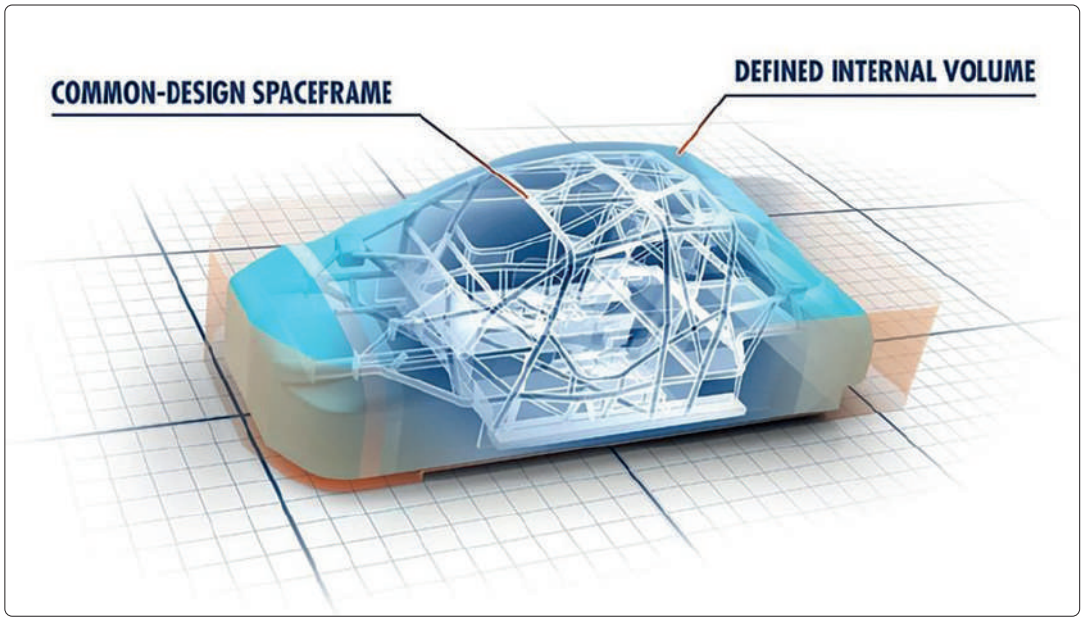
While there's clearly still work to be done, the idea of bringing hydrogen combustion into the WRC seems feasible. The current B-segment based cars might not be overly capacious, but they offer more space inside than a single-seater or a sports prototype, and the next generation of Rally1 cars will push this further with more flexibility on the design of the spaceframe, as part of a plan to enable alternative powertrains in the WRC. Even allowing for road-going liaison sections, the volume of fuel that would need to be carried onboard should be significantly less than that of a Le Mans car and there's no requirement for fast refuelling during pitstops. There again, the same benefits would apply if the WRC were to revisit hybrid powertrains or perhaps even go fully electric. So which route would Toyota like to take?

"One of the issues, is that almost every manufacturer at the moment seems to have a slightly different idea about what they want to do. At Toyota, we're saying that all options are open; others are saying that all-electric is for them, or perhaps going back towards gasoline for a while, but looking at hydrogen in the future. So, there aren't really two manufacturers who are completely aligned," comments Fowler.

"From our perspective, hydrogen certainly is an option. I think the immediate requirements of the WRC and the future requirements of powertrains are somewhat far apart at the moment. Our job is essentially to try to guide those together so that the WRC can remain a competitive environment for motorsport purposes, but if it's possible to use an alternative powertrain that aligns with TMC's requirements, that's even better." ▶

RIGHT The project is intended to help understand the limitations that come with installing a hydrogen fuel system in a rally car

ABOVE Hydrogen combustion offers the chance to keep the noise and emotion of the ICE



RIGHT As part of a plan to enable alternative powertrains in the WRC, the next generation of Rally1 cars will feature more flexibility on the design of the spaceframe

BELOW RIGHT One solution to the packaging constraints imposed by the use of gaseous hydrogen is a switch to the liquid storage already used in the GR LH2 Le Mans Hypercar testbed

The current draft of the 2027 WRC regulations doesn't say explicitly which powertrain technologies may be allowed. Instead, an appendix states that suggestions for alternative powertrains will be considered and potentially adapted into the rules. It's similar to the system used in the Dakar Rally, where Audi was allowed to put forward an electrically-driven series hybrid when everyone else was running a petrol or diesel car.

It's believed that torque sensors would be used to balance competing technologies, much like the system currently used to equate LMH and LMDh cars of various different configurations.

Toyota GAZOO Racing

"BoP a no-no in rallying"

Fowler sounds a note of cautious optimism around the idea: "The point where we have to be very careful is the difference between balance of performance and equivalence of technology. I think balance of performance is a complete no-no in rallying. When you consider the different performance characteristics that you see between a gravel rally, a tarmac rally and a snow rally – and the difference that the driver has in terms of their input – it's such a large deviation compared to a standardised performance model that you would be continuously balancing for essentially fake and fraudulent inputs, because you can never decipher where the imbalance is coming from."

It's already difficult enough, he observes, to balance cars in endurance racing, and there the organisers know exactly what each circuit has in store. Again, he believes, Rally-Raid may have the answer, with the torque sensors used to monitor the power transmitted through the gearbox rather than the car's performance against the clock.

"With that sort of model, I think the technology and the data processing would be feasible," he says. "You aren't trying to balance out the difference between who's designed the best car; you're just trying to make sure that an electric motor can do the same job as an internal combustion engine or that a hydrogen-powered internal combustion engine will be able to match the characteristics of a diesel engine. That, I think, is much more straightforward than trying to balance everybody back to the same performance level."

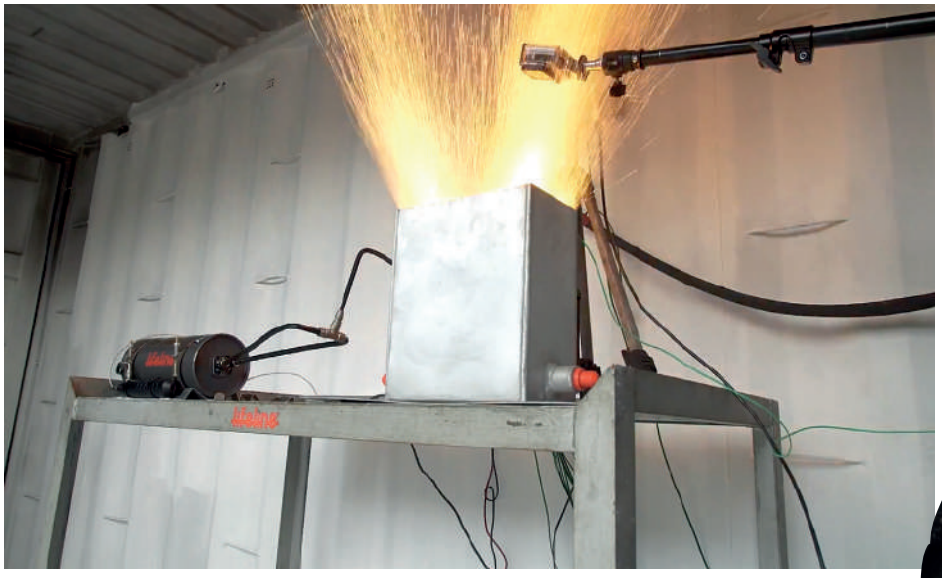
It's no secret that the WRC has its own challenges to contend with currently. The championship has just three manufacturers, one of which isn't even a full works effort. Costs have come down since the hybrid systems were axed at the start of this year, but so far that hasn't been enough to tempt any new entries into the series.

The main reasons the hybrid systems were axed were their cost and complexity. Clearly, this rings alarm bells around the idea of introducing exotic new technologies. Conversely, if the forthcoming regulations can provide a suitable platform for new manufacturers to showcase their technology it may help to stimulate the championship.

Ultimately, the best way to gauge whether or not a technology is likely to be viable is to get out and try it. And that's exactly what Toyota is doing.

BURNING ISSUES

As motorsport embraces alternative powertrains, new safety risks emerge. **Chris Pickering** speaks with one of the pioneers working to confront them



BELOW LEFT The dangers of thermal runaway, tested here at Lifeline's facility, take motorsport safety into new territory

BELOW The technology and protocols for fighting conventional fires are both well-established. The push for alternative powertrains is driving safety innovation but fresh guidelines are required too

IN MOTORSPORT, new concepts are pushed to the limit – and sometimes beyond – in a very public arena. One slip can be all it takes for public opinion to turn against a technology or to play into the hands of its critics.

As a society we are habituated to some risks and hypersensitive to others; barely a day goes by without footage emerging of an "electric car" in flames on social media, but most turn out to be conventional vehicles that have been misreported. The statistics from nations like Norway and Sweden, where EV adoption is already widespread, show that they are overwhelmingly less likely to catch fire than their combustion-engined counterparts.

Nonetheless, accidents do happen. And when motorsport experiments with new technology it comes with risks and responsibilities – potentially not just to the personnel on the track but to the technology itself.

Take the much-publicised battery fire that took place at the Lydden Hill round of the World Rallycross Championship in 2023. At the start of the race weekend, an RX1e car on charge in the paddock caught fire. The ensuing blaze quickly spread to the team's other car, its transporter and its pit equipment. Nine

fire engines were called to the scene and it took several hours to bring the situation under control.

Fortunately, no one was hurt, but the loss of the team's equipment forced it to abandon the championship. The team hasn't raced since the incident.

There was more fallout to come from the incident. First, the top-class RX1e cars were withdrawn for the remainder of the season. When World RX returned in 2024 it was forced to reverse the decision to go all-electric, allowing combustion-engined cars running on sustainable fuel to return to the top category alongside the EVs.

Still, the shockwaves continued. The World Rally Championship used the same battery manufacturer for its spec hybrid units as the RX1e cars. Later that year a new rule was introduced that required the batteries to be sent back for inspection if they suffered three shocks over 15G or one of more than 25G. Shocks of that magnitude are not uncommon in rallying and the cost of having them investigated each time is believed to have been a major factor in the WRC's decision to abandon hybrid powertrains at the end of that season.

Although the two issues were not directly linked, the incident at Lydden Hill was very much on the WRC teams' minds, as Hyundai Motorsport team principal Cyril Abiteboul explained at the time: "We all know the event associated to the technology in rallycross and the side impact that it had in this sport... We need a stable technology, a technology ▶

Red Bull Content Pool

that doesn't create negativity. Because right now when we talk about hybrid, it's more in negative terms than in positive terms."

The jury, of course, is still out as to whether electrification is the best option for motorsport. But it seems unfair that one off-track incident could have such a profound impact on the course of two major world championships, when the spotlight should really be on whether the technology can deliver on the track.

Furthermore, the alternatives for sustainable motorsport, including alternative fuels and hydrogen, bring new challenges of their own. Whichever route – or routes – motorsport decides to go down, it needs to ensure that the safety equipment is adapted to suit.

Thermal runaway

"The way you approach a conventional gasoline fire, the way you approach a battery fire and the way you approach a hydrogen fire are all very different," explains Jim Morris, managing director of Lifeline Fire & Safety Systems. "With battery storage, it's about recognising the warning signs and preventing the fire before it starts."

> *"With hydrogen, you don't get a fire: you get an explosion"*

Conditions such as short circuit, overcharging or excessive discharge can cause the chemical reactions inside a cell or a group of cells to accelerate dramatically, leading to a rapid temperature rise. Beyond a certain point – typically around 110 deg C – the battery goes into chain reaction known as thermal runaway, where these exothermic reactions cause the neighbouring cells to overheat as well. Gases vented by the battery and other flammable materials can then catch fire.

"Once the battery has gone into thermal runaway, you can't suppress it," notes Morris. "It's a self-perpetuating fire; it's self-oxygenating. No matter what you throw at it, is going to keep going, even if

Bartholomew Hall

BELOW & RIGHT The flames were finally brought under control at Lydden Hill, but the fallout from the incident was felt far beyond World RX

Peter Rosenberg

you have it in a sealed box."

Modern battery management systems have sensors to detect the onset of this process. The offending cells will be electrically isolated. At the same time, the battery will typically have vent paths built into it to release hot gases and other ejected material that could ignite neighbouring cells. All of this is designed to prevent or delay the chain reaction that could otherwise take place. It means that the chances of thermal runaway are generally very low – even if one cell encounters an issue. However, the methods used in battery design and BMS control aren't foolproof, and thermal runaway can be disastrous when it occurs.

Lifeline's response has been to develop an additional level of security that goes beyond the mitigation measures that the battery's own control system can deploy. It uses a separate network of sensors to monitor the temperature and pressure of gases vented from the battery. When these pass a critical point, the system releases a suppressant through a manifold built into the battery itself. The aim is to cool the battery rapidly and prevent thermal runaway before it takes hold.

"This has proved to be an extremely effective technique," comments Morris. "Initially, we did some very small-scale tests with just three or four cells, but now we've done it up to a 300-cell pack, which would be a huge fire if it went into runaway. Not only have we been able to prevent that happening, but the beauty of the manifold system is that doesn't destroy the whole battery pack."

Burn chamber

The system has been tested in-house by Lifeline, which has one of the few facilities in the UK designed specifically to explore the characteristics of battery fires.

"We have a battery burn chamber that allows us to look at things like nail penetration, tests and thermal runaway. We've developed a method to reliably trigger thermal runaway using heater blankets to take the battery up very, very slowly to its critical point. Then we can attempt to reverse it or we can send the battery straight into thermal runaway and see what it does. Needless to say, it's all done remotely and it's a long way from our factory," comments Morris.

Lifeline has yet to use the system in motorsport, but it has been successfully applied to several other applications, including prototype mining trucks for Fortescue Zero (formerly Williams Advanced Engineering). These have the added challenge of operating underground, meaning that fire and toxic vent gases can both pose a significant hazard.

At present, the fire suppression ▶

FIA/World RX

regulations around electrified motorsport are largely confined to the use of non-conductive suppressants. Manufacturers aren't compelled to take any specific steps to suppress thermal runaway. Partly, this is a pragmatic response to the difficulties of suppressing battery fires with conventional methods (as Morris notes, "once they go into thermal runaway they go up like fireworks, there's nothing the driver can do apart from get out and get clear of the car – assuming they're able to").

So far, this situation has been avoided on the track, despite some very heavy crashes in Formula E and Extreme E to test the safety systems. However, Morris believes it will only be a matter of time before there is a battery fire in an electric or hybrid racecar.

A number of considerations would need to be taken into account to adapt the system for motorsport use. Firstly, the manifold system would need to be designed into the battery from the outset, although Morris believes this would be relatively straightforward to do.

ABOVE & BELOW Special ONE Racing's Lancia Delta Evo-e was a fan favourite, but the team ceased operating in World RX after the fire

Next, the system would need to be packaged on the vehicle. Morris estimates that a formula car would require 10 to 12 kg of suppressant, which equates to a canister of around 15 litres, plus the manifold. This may be a hard sell for a system that's not actually required by the regulations, but it could potentially save lives.

> *"Once the battery has gone into thermal runaway, you can't suppress it. It's a self-perpetuating fire"*

Big bangs

The outlook for hydrogen – perhaps the most popular buzzword in sustainable motorsport at the moment – looks no less challenging.

"With hydrogen, you don't get a fire, you get an explosion," comments Morris. "The burning hydrogen will come back down, but initially it will tend to go away from the vehicle in a fireball. What you're trying to do is suppress that explosion before it becomes a threat to life."

There are parallels here to the battery approach, as it's about detecting and containing the situation in its early stages. Again, Lifeline has yet to develop a system specifically for motorsport, but the company is in the process of validating an explosion-suppression technology for the UK Ministry of Defence, which could potentially be adapted for these applications.

"It's all about speed," comments Morris. "We can detect the fireball in 10 milliseconds. It's then 100 ▶

ABOVE The new fire suppression system designed for F1's move to sustainable fuels in 2026 is a technical marvel, weighing only 390 grams

Courtesy of Formula 1

LEFT Romain Grosjean's accident was a dramatic reminder that the spectre of fire still lurks

ABOVE EV fire suppression accounts for a lot of Lifeline's research at present. This is the company's new Zero EV system

milliseconds until we start to deploy and another 100 milliseconds before we reach full deployment. So, we've then got less than 100 milliseconds to suppress the fire."

To do this, the system must run at very high pressure. Each extinguisher carries three kilograms of hydrogen at nearly 100 bar. This is done to move the suppressant very quickly, but it also helps to vaporise it from a liquid to a gas.

As with batteries, there are no specific regulations around fire suppression for hydrogen racecars yet, although the FIA has released a series of general safety standards for hydrogen and more guidance is expected to come soon. It's understood that several potential constructors have already been in contact with Lifeline. The challenges – much like the battery system – focus on weight and cost.

"These things are fairly large items at the moment. We could miniaturise them, I think, but it would come down to market forces – are there going to be enough hydrogen racecars in the world to justify that?" asks Morris.

Sustainable fuels

So far, the biggest impact on sustainable motorsport has come from alternative fuels. To a varying extent, these all burn like conventional fossil-derived gasoline, but that doesn't mean they're all equal.

"In general, these are slightly lower energy than conventional race fuels, so they're actually easier to extinguish. You can see that just by the colour trace of the fire and the heat it gives off," notes Morris. "We've only had one fuel that has challenged us, which was a few years ago in V8 Supercars. At the time, we had to homologate a bigger extinguisher with more suppressant for the engine bay. But they're now onto the fourth iteration of the sustainable fuel and it's now back to a standard extinguisher."

Sustainable fuel is about to take on its most high-profile challenge in motorsport, with the arrival of the 2026 Formula 1 regulations. These will see all cars on the grid switching to 100 per cent sustainable blends supplied by a variety of different fuel manufacturers, each with subtly different chemistries.

> *"We've got less than 100 milliseconds to suppress the fire"*

Influenced by lessons learnt in the wake of Romain Grosjean's fiery crash at the 2020 Bahrain Grand Prix, the FIA has introduced a new homologation for cockpit fire suppression systems. Three years ago, the 8876 standard for fire suppression in open cockpit cars was introduced for lower formulae, including F2 and F3. Now, the FIA has effectively applied the cockpit portion of that standard to Formula 1.

"There's a real drive to make the cars smaller and lighter, which means that the fire suppression systems need to be smaller and lighter too," comments Morris. "We've just re-done our cockpit suppression homologation with a new design that reduces the amount of suppressant from 100g to 60g."

At 60g, the suppressant is around the same mass

as a tennis ball. It's an impressively small amount to deal with potentially life-threatening scenarios. This compact design uses an innovative concept with a pressurised bladder, Morris explains.

"The suppressant is a powder. You can imagine that if all you do is put that into a bladder and apply pressure to the outside it just turns into a ball," he says. "We've got a patented system that allows us to create more energy within the bladder. It works by a process known as decrepitation: as the powder gets hot, it explodes; we use lots of little explosions, which produce smaller particles and effectively snuff the fire out. To do this, we use a grade of aerospace powder that's really, really efficient."

Fire may be a far less common hazard in Formula 1 than it was in the grizzly days on the 1960s and 1970s, but it certainly hasn't gone away, as Grosjean's accident demonstrated. And while next year's sustainable gasoline might not represent a particularly big shift in fire safety, future options like hydrogen may be a different matter. In a world where new technology is instantly placed under the less-than-expert microscope of social media, it's vital to ensure that the industry keeps on top of these emerging challenges. RT

ABOVE R&D conducted for the defence sector could have applications for motorsport. Lifeline devised this system for the Warrior tank

BELOW MissionH24 is paving the way for hydrogen racing at Le Mans. Safety has historically lagged behind technology but a combination of engineering ingenuity and regulatory oversight is required to make electric and hydrogen racing as safe as their ICE predecessors

MissionH24/Thierry Gromik

WHEN EVERY SECOND COUNTS

Anthony Peacock travels through time with Nick Biebuyck, TAG Heuer's Heritage Director

THE technological arms race of modern Formula 1 is such that most records and milestones are merely ephemeral. But there is one benchmark that has stood since 1971 and seems unlikely ever to be beaten (outside of a Hollywood film set). And that's Peter Gethin's defeat of Ronnie Peterson at the 1971 Italian Grand Prix by a mere 0.010s. Making it all the more remarkable was the fact that the top five were famously covered by 0.061s – and none of them had ever won a race before (Gethin would never win one again).

That moment underlined a fundamental truth: timing is everything, not only defining strategy but making history. Yet in the earliest days of Formula 1, timing was almost an afterthought. Races were measured not by automated systems or digital

readouts, but by busy human hands clutching mechanical stopwatches.

There may have been an inherent romance in this analogue approach, but also an ever-present margin for error. As was the case with so many things back then, human judgment played an oversized role in a sport that would one day come to prize data-driven precision above all.

Let's go back to that remarkable 1971 Italian Grand Prix at Monza. Jacky Ickx had initially claimed pole position with a lap time of 1m 22.82s. But Michele Dubosc, Formula 1's first official timekeeper – who then went on to join the Matra team – contested the timing with her own stopwatch registering a time of 1m 22.40s from another driver, Chris Amon. Who happened to be driving for Matra...

Yet such was her reputation that the officials accepted her timing, and Amon was bumped to the front of the grid (ultimately finishing sixth in the race). The whole episode wasn't a unique occurrence: merely emblematic of a system that relied heavily on trust and eyesight rather than technology.

The turning point began later in the 1970s, as electronic timing systems started to make their way into motorsport. At first, these were used primarily for photo finishes, integrating light sensors and high-speed line-scan cameras to capture the precise moment a car crossed the finish line.

These systems were much more accurate and removed a lot of ambiguity from lap times. But they still relied on external triggers and could not independently verify exactly which car had crossed a timing line, until the introduction of transponder technology.

And that was thanks to Heuer, an ambitious Swiss timekeeping brand, which had been involved in Formula 1 as a prominent sponsor since the late 1960s, when the original company founder's great-grandson Jack Heuer first befriended up-and- ▶

RIGHT The Formula 1 Solargraph returned TAG Heuer to its roots. It is reminiscent of the iconic 1980s models but now with solar-powered quartz movement and contemporary design

BELOW TAG Heuer returned to the role of official F1 timekeeper this season

coming starts like Jo Siffert and Jochen Rindt.

But Heuer already had a long history in motorsport, even as the sport itself was being invented. In 1911, the company produced its first dashboard chronograph, the 'Time of Trip', which allowed drivers (and aircraft pilots) to measure journey times.

"It was a genuine revolution," says Nick Biebuyck, TAG Heuer's Heritage Director. "To be able to time an event to such a precise degree, and in such a practical format, laid the very foundation for everything that would follow in motorsport timing."

Biebuyck is talking about innovations such as the Heuer Mikrograph in 1916: the world's first stopwatch capable of measuring to a hundredth of a second. In an era when racing was maturing from chaotic exhibition runs into competitive sport, Heuer was actually first to provide the tools to quantify speed with scientific accuracy.

The Mikrograph became a regular sight at sports events worldwide, and the same could later be said of Heuer's Rallyetimer: clocks which were originally designed to be mounted inside rally cars for use on regularity and speed events. But these systems were all still ultimately manual.

ABOVE Frank Williams clutches the stopwatch – a far cry from the automated systems that rule our sport now

ABOVE RIGHT Heuer's Rallyetimers, clocks originally designed to be mounted on rally car dashboards, changed the motorsport landscape

RIGHT Peter Gethin beat Ronnie Peterson by a scant 0.010s at the 1971 Italian Grand Prix, with the top five cars covered by 0.061s

The big shift came in 1974, when Heuer's Automatic Car Identification Timing (ACIT) system made its debut: using the same principle that still governs timing today.

For the first time, Formula 1 cars were equipped with onboard transmitters that emitted a unique signal. As a car passed over a loop of wire embedded in the track surface, its transponder would trigger a decoder and log the precise moment it crossed the finish, down to the nearest hundredth of a second.

The system could automatically differentiate between each car on track, recording individual lap times without human intervention.

"It's easy today when you see unlimited numbers of watch and car partnerships taking place to think that every brand has a legitimacy in this space," adds Biebuyck. "But I think no other companies can compare to that of Heuer and TAG Heuer. From virtually the beginning of the company in 1860, the focus has been on the chronograph, and that's eventually evolved into what we see today in motorsport."

> ***"We could move beyond millisecond accuracy through quantum clock technology which can measure one quadrillionth of a second"***

Over time, this transponder-based system was refined, improved, and copied. Signals became faster and more reliable, while trackside loop density increased to allow for more frequent time checks. Cars could now be timed every 150 to 200 metres, creating a detailed performance map of each lap. Teams began to harness this data not just for race results, but for live strategy and car development decisions. Timing was no longer about determining who finished first; it became a tool for analysing every corner, every braking point, every acceleration zone. Just as it is today.

This was what cemented Heuer's reputation in Formula 1, but the company had already broken new ground in 1971 by becoming the first watch brand to officially sponsor a Formula 1 team: Scuderia Ferrari.

Heuer created the Le Mans Centigraph system in the early 1970s, a suite of timing equipment so advanced that Ferrari used it at their Fiorano test facility, cementing the relationship between the Prancing Horse and Heuer.

Jean Campiche, the legendary timekeeper known as 'The Pianist', operated the system with a virtuoso's touch, such was its cutting-edge complexity. And

it no doubt had a lot to do with Ferrari's phenomenal rate of car development, which is what made the difference for them throughout the 1970s.

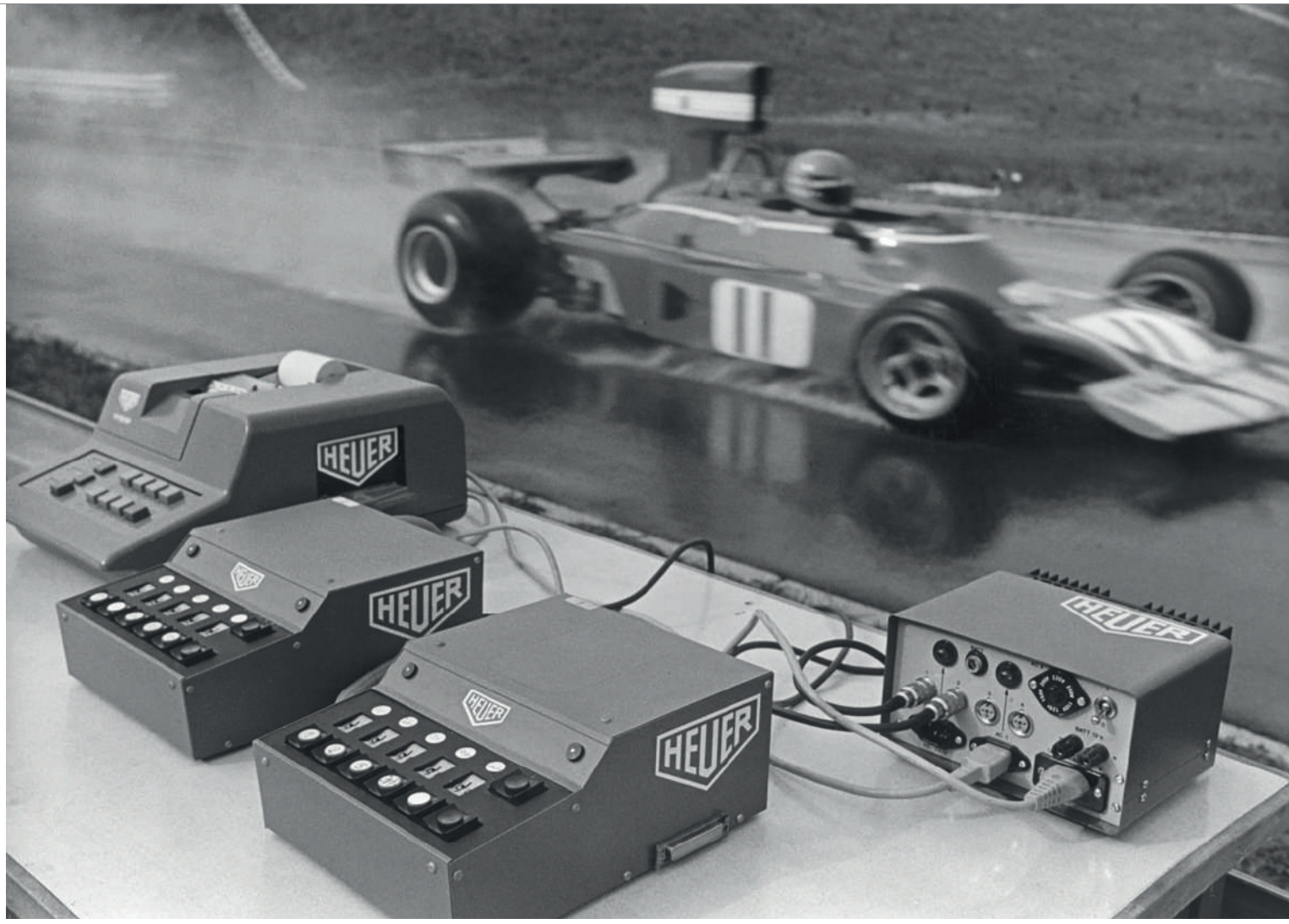
The Heuer logo had actually been seen on an F1 car two years before – the 1969 Lotus 49B of Jo Siffert – but that was more down to a friendship between Siffert and Jack Heuer than a formal arrangement with the team.

Golf course deal

"How the relationship with Siffert began is one of my favourite stories," explains Biebuyck. "It all started on a golf course. Jack Heuer was playing golf with his bank manager, explaining how he saw motorsport as being a key way to sell watches. He realised that the people who were into motorsport were Heuer's natural customers: they all had a fascination for mechanical objects and were interested in technical topics. Then his bank manager suggested that, in which case, he might want to get involved with this young driver called Jo Siffert, who was after a bit of help. Sure enough, they hit it off and the next year, the Heuer logo was actually on Siffert's car. So that was another moment that changed everything. It was when Heuer became more than just a supplier."

Siffert, in fact, was arguably the world's highest-paid watch salesman. He was on a modest retainer from Heuer, but was paid a commission on every watch sold to a fellow driver...

He was remarkably successful. "So many famous drivers ended up wearing them that our watches become more than just a timepiece, but instead a piece of good luck," adds Biebuyck. "Jack would often inscribe an inspirational message on the caseback, so they would become ▶



talismans for these drivers. As a company, it gave us a cultural resonance that hadn't been seen up until then at a watch brand..."

ACIT was a game-changer, but in the 1980s, telemetry began to take hold – which shifted the goal posts of chronometry even further.

Initially limited in scope, early telemetry systems could store only a few laps' worth of data, and engineers had to manually prompt the car to begin recording.

Quest for technical perfection

As data storage and wireless transmission improved, these systems became vastly more powerful and fully integrated with timing. Engineers could receive real-time information about engine performance, tyre temperature, fuel consumption, and – crucially – exact lap and sector times. Timing wasn't just for the official record anymore: it had become a core part of the relentless quest for technical perfection.

Heuer was far from the only watch brand to be involved: companies such as Longines and Rolex also had a strong presence, each bringing not only their unique expertise but also new areas of business. Longines stepped in during the 1980s, working with computing giant Olivetti to develop race timing systems that formed the backbone of Formula 1's official results from 1982 to 1991, just as telemetry blossomed.

ABOVE In 1972 the Le Mans Centigraph, designed for Ferrari, became the benchmark for motorsport timekeeping. It was adopted by racing teams worldwide as the pinnacle of accuracy and innovation

Seiko and Casio, though more associated with affordability and digital innovation, also found visibility through partnerships with teams like Lotus and Williams. These relationships were less about luxury and more about showcasing technical performance. Suddenly, every driver had their own watch deal. Charles Leclerc has even invested in a luxury watch auction platform.

> *"Timing was no longer about determining who finished first; it became a tool for analysing every corner, every braking point"*

But individual partnerships between watch brands and drivers were often a lot more obscure in the early days. Back in the 1960s, Jim Clark used to have a strong relationship with the Enicar brand; a name that had nothing to do with cars at all but was instead the surname of the brand's founder, Racine, spelt backwards. Mario Andretti's first watch was a Wesley's — an American brand that was

LEFT Heritage Director Nick Biebuyck keeps TAG Heuer's roadshow on track, with famous watches and artefacts constantly exhibited around the world

subsequently mothballed.

Yet perhaps the single most remarkable episode in Formula 1 timing was on Seiko's watch in 1997, when during qualifying for the title-decider at Jerez, the top three on the grid (Jacques Villeneuve, Michael Schumacher, and Heinz-Harald Frentzen) all set exactly the same time: 1m 21.072s. Cue the conspiracy theories...

But there was no conspiracy. The sheer precision of modern Formula 1 timing, encapsulated by that moment, is almost beyond comprehension. Biebuyck makes an interesting point, as timing has become a spectacle in its own right, with qualifying sessions and fastest lap awards turning raw data into fan engagement and strategic opportunity.

Timekeeping revolution

"Seeing live timekeeping data that was being processed on site and broadcast globally to audiences at home for live feeds was a revolution," points out Biebuyck. "It's a big part of what makes Formula 1 the entertainment powerhouse that it is today."

And that was probably why Rolex – the world's best-known watchmaker – also seized the opportunity to become the sport's official timekeeper right up until the end of last year, when a record-breaking 10-year deal worth a reported billion dollars was sealed with the LVMH conglomerate, which included TAG Heuer as official watch brand and timing partner.

With the deal announced to coincide with the 75th anniversary of Formula 1, the association carried even more historical resonance.

Rolex did an astonishing job during its tenure to elevate the image of F1; emblematic of its attention to detail was the presence of Sir Jackie Stewart as the company's longest-serving brand ambassador at many of the races, who insisted on having one crisp white shirt sleeve tailored slightly higher than the other, in order to properly show off whichever Rolex watch he was wearing.

TAG Heuer now aims to usher in a new era, where the records are not solely commercial. The future of F1 timing is focussed on innovation: faster data transmission, enhanced visualisations, integration with AI-assisted strategy, and even tighter synchronisation between driver, machine, and the clock.

And at this point, it's worth mentioning how Heuer evolved into TAG Heuer, which was another relationship born directly from Formula 1.

By the early 1980s, the entire Swiss watch industry was reeling from the so-called 'quartz crisis' as cheap and accurate Japanese quartz watches flooded the market, making traditional mechanical watches almost redundant. Heuer, like many other Swiss brands, struggled to adapt. In 1982, Jack Heuer was forced to step down and sell the company.

Enter the Ojjeh family: specifically, Akram Ojjeh ▶

Ferrari

BELOW Niki Lauda flying Heuer branding for Ferrari (above). Enzo Ferrari wanted Heuer to pay his hefty driver salaries but the Swiss company forged a collaboration that would see drivers Lauda and Clay Regazzoni become ambassadors for the brand (below)

– a wealthy Saudi entrepreneur with a passion for engineering and technology – along with his son Mansour Ojjeh. The Ojjehs owned a technology investment firm called Techniques d'Avant Garde (TAG), which already had strong ties to Formula 1, having invested in McLaren.

In 1985, TAG acquired Heuer and merged the two entities into TAG Heuer, with Mansour Ojjeh pointing out: "We believe that precision timing and high-performance engines belong to the same universe."

"Don't Crack Under Pressure"

TAG famously branded McLaren's Porsche F1 engines in the 1980s (one company, Lanzante, has now installed them in road-going 911 turbos) and nearly 30 years later – long after the TAG McLaren era – history repeated itself when TAG Heuer became the alter ego of Red Bull's Renault engine. "That's how closely woven in TAG Heuer is to the fabric of Formula 1," explains Biebuyck.

When Ayrton Senna joined McLaren in 1988, he naturally became a TAG Heuer ambassador, promoting the brand through the now-famous 'don't crack under pressure' tag line.

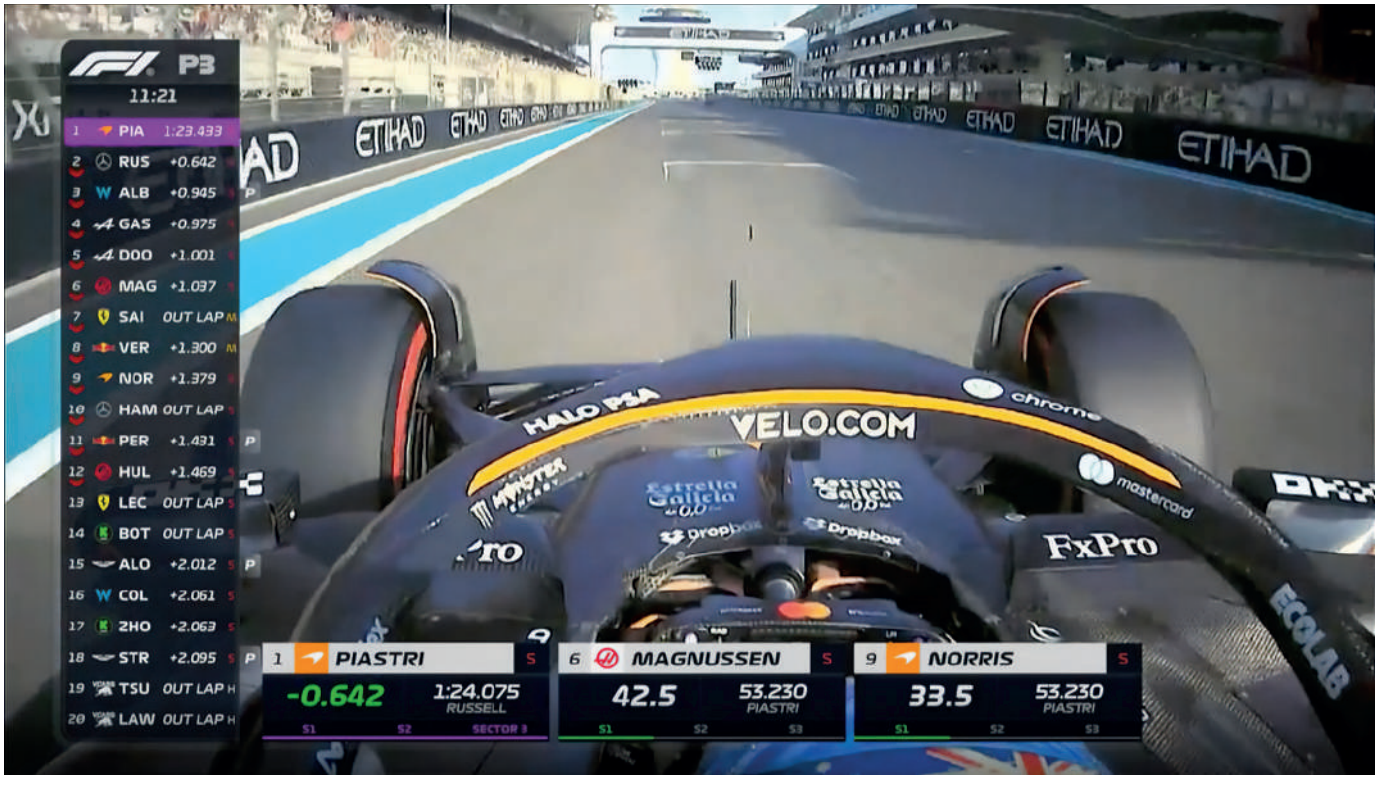
Appropriately enough, this mantra was also used to sell watches with Kimi Raikkonen (Kimi's favourite F1 driver, James Hunt, was yet another regular wearer of TAG Heuer watches decades earlier). But there was no doubting who was the company's biggest star.

"Senna had this magnetic presence," says Biebuyck. "When he wore something, it became iconic. But more than that, he embodied everything we stand for: mental strength, precision, elegance under pressure. Even now, more than three decades later, he's still part of our identity."

ABOVE Jack Heuer shaped the company's direction and introduced iconic timepieces

All drivers – and watchmakers – aspire to Senna-like levels of hyper-achievement, but what makes TAG Heuer different is that there's a watch for everyone, and F1 is again at the heart of the story.

In 1986, the 'Formula 1' watch was presented to the public for the first time. And it was cheap: a quartz and plastic watch that was as brightly coloured as the Benetton F1 racers of the day. It provided a valuable entry ramp for young fans and sold in huge numbers, but this didn't sit well



BELOW Live timing data has become an ever-greater part of the way in which fans experience the sport

LEFT & BELOW Two of the brand's legendary ambassadors: Steve McQueen (who starred as Michael Delaney in the film 'Le Mans', below) and Ayrton Senna. More than three decades after his death, Senna remains a huge part of the company's identity

BELOW The racing heritage of TAG Heuer's Monaco collection, featuring a distinctive square case and automatic chronograph movement, make it a favourite among connoisseurs

with the LVMH Group, which acquired TAG Heuer in 1999 with the firm aim of elevating the brand.

As Biebuyck puts it: "If you want to expand yourself as a luxury brand, how can you be selling an entry level watch, particularly if it's quartz – which isn't considered to be premium by many connoisseurs – and you're using materials like plastics and composites? It's a tricky balancing act. So in 2000, the F1 collection was removed."

But there's an inevitable circularity to most stories in motorsport. The 'Formula 1' watch returned in 2004, but as a higher-end mechanical watch, with the company having noticed the hole in the balance sheets blown by its absence. This was the watch worn by Lewis Hamilton in his first year of Formula 1.

And while it continued in various forms over the years – including special editions for Red Bull – it was only this season that TAG Heuer went back to its roots by releasing the Solargraph: a watch that's very reminiscent indeed of those 1980s models but now with a solar-powered movement. Overgrown versions of it are prominently used as clocks throughout the F1 paddock, and there are also special editions available tied to specific grand prix locations. Again, this is something that was seen before, with Heuer releasing the 'Monza' watch back in 1976, to celebrate Niki Lauda's first championship with Ferrari a year earlier.

Then there's the future, which is staggering. We could well move beyond millisecond accuracy through the adoption of quantum clock technology, which can measure time intervals up to the femtosecond level: one quadrillionth of a second. This leap would allow teams to see minute performance differences that are currently undetectable. Advanced LIDAR and optical tracking systems could also complement or even replace traditional transponder setups. These technologies are capable of delivering real-time positional data with unprecedented levels of accuracy across the entire circuit. The result will be not only more dynamic team operations but also an enhanced viewing experience, as spectators gain access to more detailed, customisable, and interactive race data.

While it's impossible to accurately predict what comes next, the following generation of F1 timing systems will not only redefine measurement standards, but will also become even more deeply integrated with strategy, gaming, and fan engagement. With the ultimate aim of bringing more people closer to the sport.

"Innovation, resilience, equality: those aren't just buzzwords. They're what drive us," concludes Biebuyck. "Time doesn't stand still, and neither do we." RT

MERCEDES F1 TRADES IN ITS SILVER ARROWS FOR GREEN

Considered one of the most sustainable global professional sports teams, Mercedes' sustainability plans tease what's next for Formula 1. By **Olivia Hicks**

MAKING motorsport more sustainable isn't all that different from implementing a new regulation era in Formula 1.

First, there's brainstorming: analysing the automotive market for anticipated gaps in innovation, drawing the contours around what is technologically possible and pushing beyond those boundaries. Second, there's the reality check of trialling, feasibility and meeting deadlines. Finally, the ideas float off the page and out of the research and development stage onto the track. The best stage.

Throughout it all, teams are using the grey areas to push each other further and returning to the drawing board to restart the process with higher stakes.

If you were to ask Alice Ashpitel, Mercedes-AMG Petronas F1 Team's head of sustainability, what stage the team is currently in, she'd say the "fruition" phase.

It was only six years ago when Formula 1 came out with its first sustainability report, but the sport's individual teams have been quietly taking charge behind the scenes.

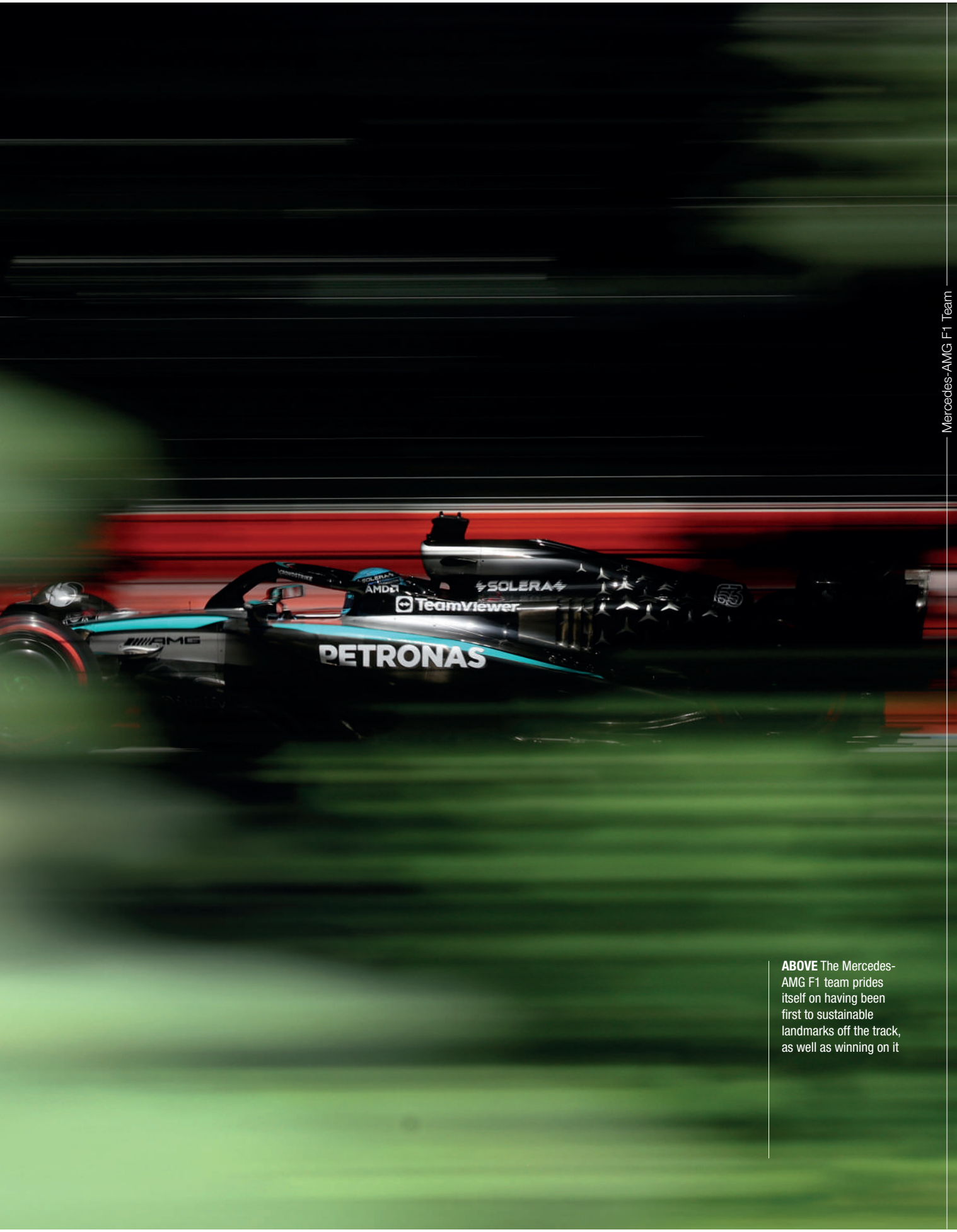
Mercedes, for example, began investing in Sustainable Aviation Fuel (SAF) in 2012, long before the alternative fuel source that aims to minimize Formula 1's largest carbon emissions output was on most industries' radar. The team reduced 9,860 tonnes of carbon emissions through SAF in 2024 and quadrupled the volume of the fuel used between 2022 and 2025 in an effort towards making "economies of scale".

The team had the same brand of stewardship in bringing HVO100-fuelled trucks into the race calendar during the sport's European stint. An alternative fuel source made from 100 per cent cooking oil, Hydrotreated Vegetable Oil (HVO) was an appealing option to slash Mercedes' transportation emissions across the summer Formula 1 months when the team's travelling circus is packed up and driven across the continent. F1 and the FIA have started their own HVO project – partnering with DHL to fuel race logistics – and Mercedes is beginning to talk with other teams that are implementing similar projects.

Trialling began in 2022 when Ashpitel joined Mercedes-Benz Motorsport as its sustainability manager. When she became head of sustainability for Mercedes' Formula 1 squad the following year, the team was already rolling out the HVO100 trucks with a 67 per cent emissions reduction. According to Ashpitel, the team is now at 98 per cent across the European season.

> *"The most exciting sustainability development to keep an eye on this year is where materials will go"*

In two industries – motorsport and sustainability – where the increments of progress can be hard to grasp, it's one of Ashpitel's proudest achievements. The results were obvious: no drop in performance or delivery time, and the alternative fuel source didn't ▶



Mercedes-AMG F1 Team

ABOVE The Mercedes-AMG F1 team prides itself on having been first to sustainable landmarks off the track, as well as winning on it

clog the engine. "It's just such a visible aspect of the sport," she says. And it took just a few years.

"In three years, we've moved from a European season on diesel to a European season where actually all of the generators in our paddock were completely run on this alternative fuel – which from outside of a purely carbon perspective, from an air quality perspective, the NOx emissions are 90 per cent reduced," she says. "When you think about the fact you're putting people to work in a paddock environment, you want it to be clean and safe for them."

Pressing question

But the pressing question on everyone's minds isn't necessarily logistics-based. Motorsport's success as a research and development testing bed for the automotive industry has largely been in pushing for technological and safety improvements that can be translated to an everyday driver's commute.

In the sacred high-speed oval that is the Indianapolis Motor Speedway, the rearview mirror was introduced to the world and would forever change the way we reverse. While series like Formula 1 are expanding their influence to other industries by serving as an early adopter of SAF and increasingly accepting non-automotive sponsors, the sport likely won't ever shake its inherent ties to the road vehicle world. In recent decades, racing has inched away from inventing new mirrors and begun to push the limits of what is possible within the confines of a 5.63m x 2m x 0.95m car.

Back in 2009 with the introduction of the Kinetic Energy Recovery System (KERS), Formula 1 began

> *"The first step in merging sustainable sourcing rules into future technical regulations"*

to develop what is known in most road cars today as a form of regenerative braking by taking existing technology and pushing it further. The system's greatest outcome – improving the power density of lithium-ion batteries – laid the foundation for a future of sustainable technical development. But KERS, with its added weight and unreliability, also came with a reality check that the sport has been attempting to overcome ever since: making Formula 1 both sustainable and fast.

Sixteen years later, Formula 1 is about to enter a new regulation era with hybrid technology woven through the bylaws. But as teams draft up power units within the outlines of the 2026 technical regulations, they are also looking beyond the engine and into the materials that create a cocoon around a Formula 1 car's most precious parts.

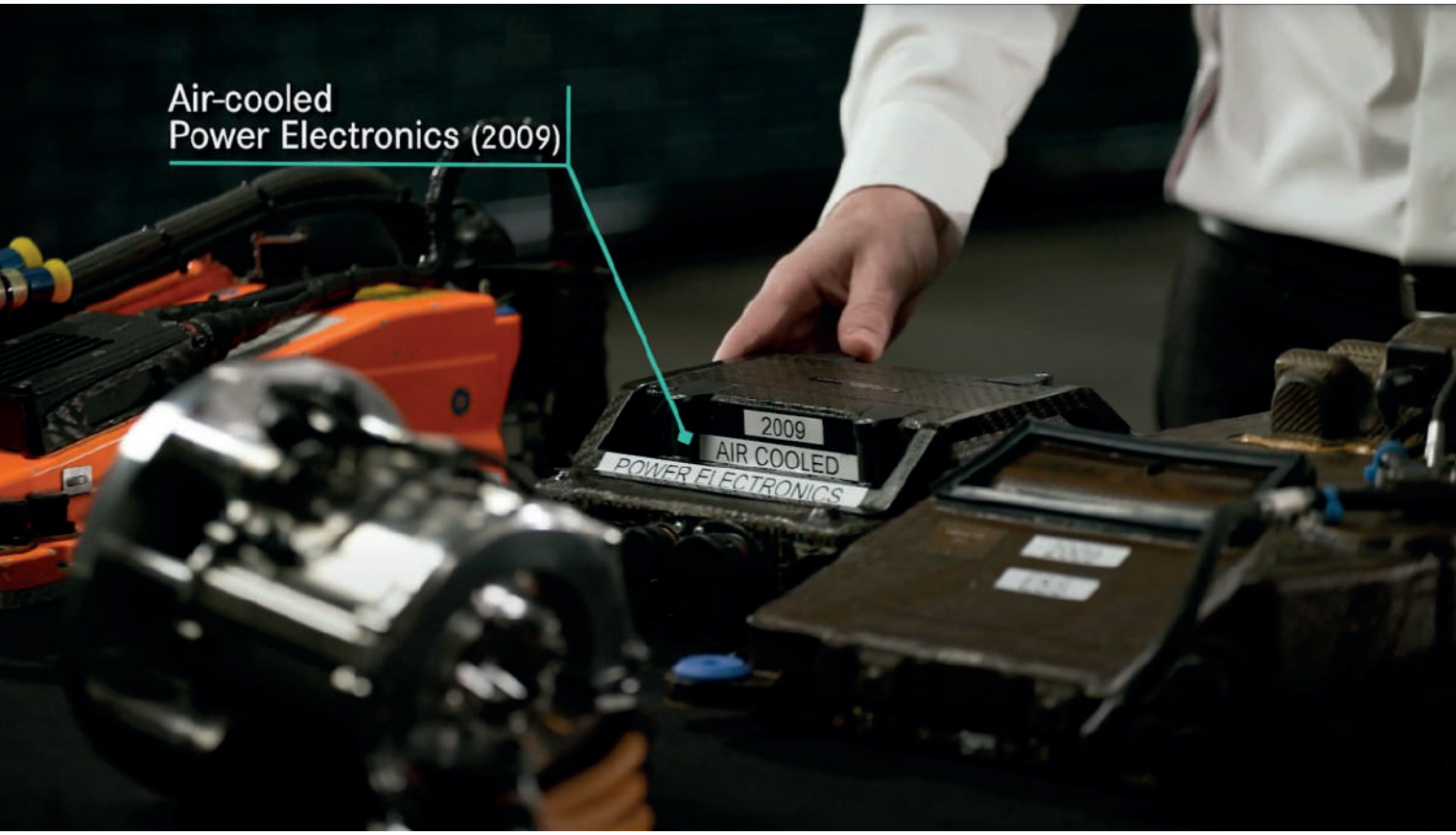
The most exciting sustainability development to keep an eye on this year, in Ashpitel's opinion, is where materials will go.

The McLaren MP4/1, the product of John Barnard's brain stamped with a Marlboro logo, was the first Formula 1 car to wear a shell entirely made of carbon fibre. So, it was only natural that McLaren became the first on the grid to introduce recycled carbon fibre. Sauber is also testing sustainable carbon fibre to manufacture its front wing flaps.

However, while a Formula 1 car made of recycled carbon fibre looks like a flashy sustainability win on the surface, the scale, cost and logistics of bringing the idea to the track mean the process is slow-moving.

Mercedes is trialling both sustainably sourced carbon fibre and resin as options for future car development. According to the team, carbon fibre composites make

BELOW Alice Ashpitel, Mercedes-AMG Petronas F1 Team's head of sustainability



ABOVE & RIGHT
This is the moment (right) that Lewis Hamilton deployed KERS to make history, overtaking to become F1's first hybrid winner in Hungary in 2009. The system (above) was the catalyst for advances in battery tech and power management that would help shape future high-performance EVs

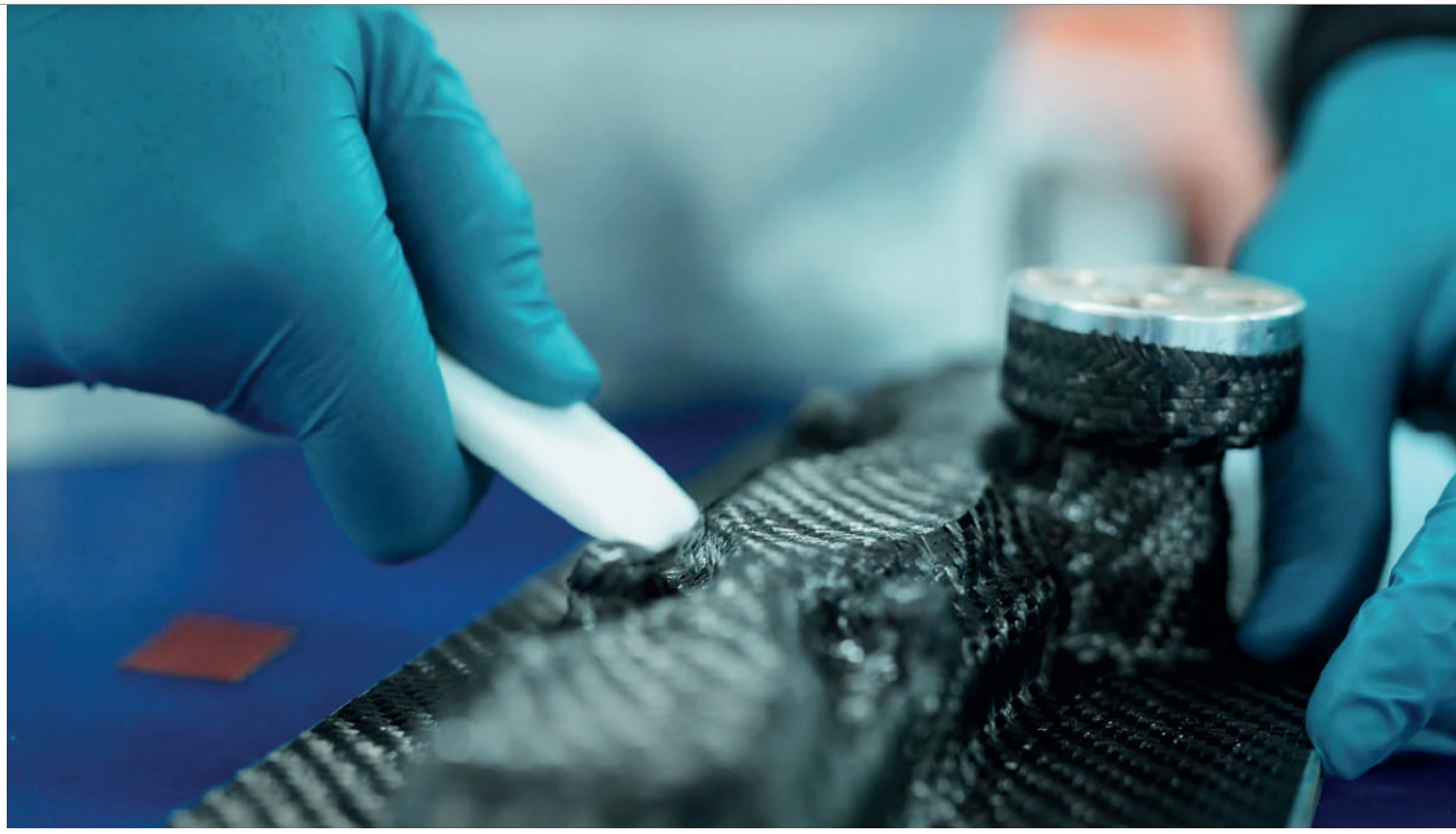
up 75 per cent of the W16 car.

"Working closely with the FIA within the scope of the relevant regulations, we aim to demonstrate that sustainable carbon fibre composites can perform to the same technically demanding requirements as traditional materials," Mercedes announced ahead of the season. The team partners with carbon fibre composites manufacturers Sigmatex, Syensqo and Toray.

But the team is only in the first steps of making a carbon-intensive material greener and it isn't exactly a straightforward process. To create each composite component, anywhere between four and eight suppliers are involved. While Formula 1 is considered "the world's fastest test lab", the links in its supply chain sometimes appear almost antiquated.

"You've got a blend of small, medium-sized enterprises – small, family-owned businesses that sit in the motorsport corridor," Ashpitel says. "There is a real kind of a small, medium-sized community supplying really high-quality, high-end parts but very bespoke." But then there's also multi-national corporations supplying parts, office equipment and factory machinery.

As Mercedes and McLaren make progress towards sourcing more environmentally-friendly carbon fibre for their chassis, the sport's ruling body introduced a Circularity Handbook in collaboration with McLaren and Deloitte UK in an effort to modernize the sport's supply chain. The guidebook is less of a set of strict regulations and more of a loose educational read without clear guidelines ▶



for end-of-life material processing. But in a press conference in April, the three partners said that this could be the first step in merging sustainable sourcing rules into future technical regulations.

"A lot of the work that we will be focusing on this year is about supply chain education and really helping those small, medium-sized companies who don't have dedicated sustainability teams start their transition journey and bring them along on the journey to net zero," Ashpitel says.

Tech that doesn't exist yet

Mercedes was the first motorsport team to sign a climate pledge last year that requires hitting net-zero carbon emissions across scope one, two and three emissions – including suppliers – by 2040. "The reason we've got that longer timeframe for 2040 compared to 2030 for race team control is because our supply chain will need time to get there," she says. "A lot of the technology doesn't exist right now. So some of the materials that we will be trialling and exploring over the next couple of years with them will be brand new."

Creating and sourcing that technology, especially through a sustainability lens, is costly. One of the key wins this year and going into the next is unlocking the cost cap to allow for sustainable development outside of the $135 million team budget.

While Formula 1 teams are beginning to see progress in changing public opinion and convincing fans that sustainability can match rather than sacrifice speed, suppliers and investors often need reassurance about up-front costs. Just like opting for cheaper oranges over organic options in the grocery aisle, anything that has the words "sustainable" or "environmental" in front of it is associated with a kind of luxury few can afford – especially teams lower down the Formula 1 grid.

ABOVE Could the quest for more sustainable carbon fibre lead to a materials breakthrough? The team has two ongoing projects in this area

Mercedes was one of the teams that worked with the FIA to allow for investment in SAF and HVO100 projects outside of the cost cap. "Although the cost cap is a uniquely Formula 1 thing, cost pressures are not a uniquely Formula 1 thing," Ashpitel says.

But upfront costs can often force a team to be more resourceful, she says. "That's where you add performance because being more efficient is actually being more performant, performance-based and more sustainable. So I don't think they are innately in conflict and where they are, that's where we've worked with the FIA and continue to work with them on things like SAF, which if we're honest right now is a cost burden, but it's the right thing to do to help scale the sector." ▶

BELOW Mercedes was a SAF pioneer

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LEFT Last month Mercedes became the first team to use electric trucks – Mercedes-Benz Trucks eActros 600s – to transport its cars to a European GP

BELOW Approximately 75 per cent of this year's W16 is made from carbon fibre. Once F1's skill with the material ranked among the sport's finest achievements, but now its use is a sustainability challenge

The team has used that same short-term cost, long-term investment strategy to develop its carbon credits programme as well. Mercedes bought just over 5,000 tonnes of carbon removal credits spanning 2027 to 2030. And over 11,000 tonnes of "nature-based carbon removals" will be delivered from 2024 to 2030.

"We recognize that's not a huge part of our footprint," Ashpitel admits. The team's most recent sustainability report, released in early July, calculated a 63,782-tonne total footprint. "It forms part of a wider portfolio," she says. That portfolio includes investing in soil carbon removal in the UK and more "permanent"

carbon removal projects.

Carbon purchasing has received backlash with its opponents arguing that it allows large corporations to buy their way out of implementing sustainable policies. It's part of the reason why most companies look like they will meet net-zero deadlines on paper, but not in practice. When pushed about meeting those goals, Ashpitel says Mercedes is interested in being realistic and transparent: "How do we build real credibility in both what we buy and how we report? Because it is a new market, and there's always a real need to be transparent."

Part of that honesty is reporting emissions wins and losses. According to the Mercedes F1 Sustainability Report published in 2024, the team had reduced total emissions by 13 per cent compared to 2018 and in the most recent report, market-based Race Team Control emissions fell by 35 per cent compared to 2022. But even with progress, the team's overall emissions in 2024 increased by 18 per cent compared to 2022 – largely due to the supply chain. The sport's desire to enter untapped markets, expand the race calendar and bring new eyes to the track is a constant challenge for its 10 teams.

Mercedes-AMG F1 Team

ABOVE Bringing sustainability into the factory has been one of the biggest shifts

Growth grief

"We've added a race to the calendar in '23 and in '24," Ashpitel says. "So how do we deliver that growth of the sport, but decouple resource consumption from that growth? How do we look at using our resources more efficiently, be it at the factory, when we go travelling or when we're on track?"

Bringing sustainability off the track and into the team's Brackley-based factory is perhaps one of the biggest shifts Ashpitel has seen in the past few years: going from looking at sustainability as external to internal. When a team like Mercedes sets a lofty target – no matter if it's on the pit wall or in ride sharing to the office – everyone with brains hardwired to innovate begins asking, "How do I do that?"

It's one of the main reasons why she views Formula 1 as the perfect way to push sustainability forward. Even if the sport is historically the antithesis of environmentalism, it's proving it is still relevant as a test bed where something as obscure and buzzwordy as "sustainability" can be visible in real time.

So, what is next? For the sport, it looks a lot like Mercedes' current benchmarks. For the everyday person, it could look like a plane ride in a few years' time or a delivery van being fuelled by something a Formula 1 team trialled.

We might not be able to pilot a race car or peek inside a team's under-lock-and-key wind tunnels, but something as simple as chip oil-turned-fuel could make us feel a little closer to the sport.

BUGZAPPA'S RACE TO THE CLOUDS

Hal Ridge reports on an eye-catching assault on the iconic Pikes Peak International Hill Climb

FORD is the latest marque to mount an all-electric attack on the famous Pikes Peak International Hill Climb, but the trend for works teams to use electric technology began in earnest in 2018 with Volkswagen's I.D.R.

And while Ford Performance, in collaboration with Austrian outfit STARD, continued to target outright success with its Super Mustang Mach-E this year, there was also an electric Volkswagen lurking on the start list.

Car number 56 was admittedly a rather more modest affair than the huge-budget works effort, but it did share some commercial similarities with the big dogs.

The participation of the big manufacturers is all about showcasing technologies and making production offerings attractive to consumers. For Mid Wales firm Electric Classic Cars [ECC], its Volkswagen Beetle named BugZappa has similar commercial links.

ECC boss Richard Morgan, known as Moggy, has been successfully converting production vehicles to electric specification for customers from his Newtown workshop since 2015. As someone bitten by the competition bug, with seven years of historic rallying under his belt, he has three 'bucket list' targets: Pikes Peak, the Paris Dakar Classic and Baja 1000.

Bucket-list with a difference

Needing to align with his own commercial exploits, thus creating an electric concept, Morgan reasoned that Pikes Peak is most similar to his rally heritage. He therefore began assessing his options to take on one of motorsport's most celebrated challenges.

"I considered a number of options and it kind of came down to a couple, including an Ultima GTR, which is a very good car. Actually, it's probably ideal for Pikes Peak in terms of the aerodynamics and the handling being spot on, but I just thought it was a little bit boring. It's just like every other race car: it's pretty cool, but it's certainly not distinct. Having been into VW Beetles all my life, I thought, you know what, let's just go with a Beetle. And it was the right decision, because at Pikes Peak we had a massive crowd around the car all the time and there were other full-on race cars that weren't really getting much of a look in. As a crowd-pleaser, the Beetle was definitely right, but as far as everything else, it was probably the wrong way to go. It has proved a challenge, certainly."

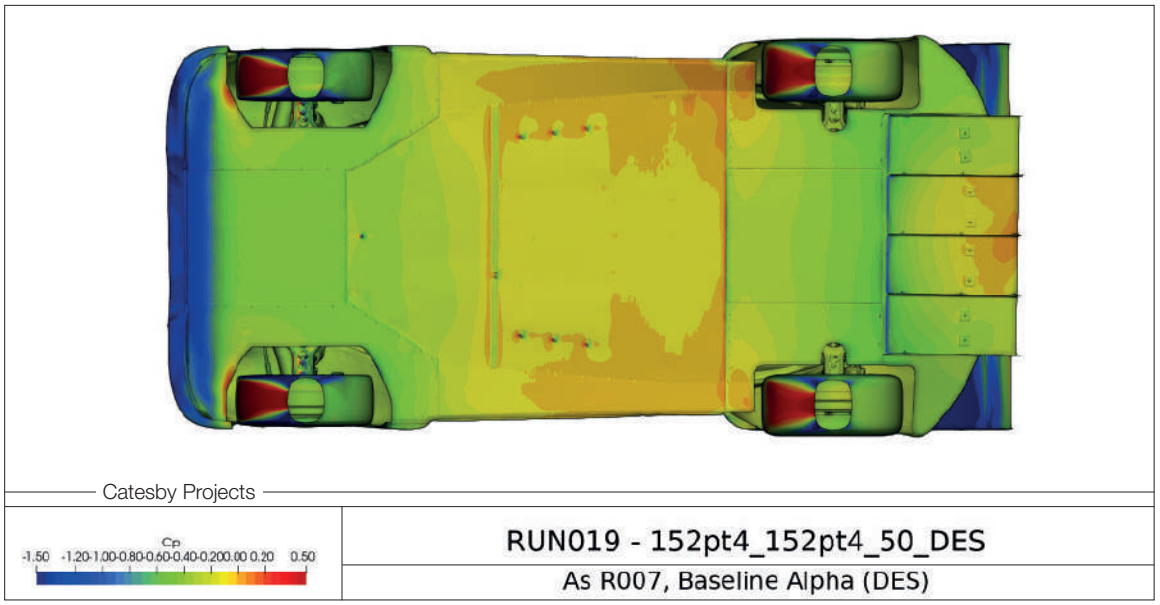
Rather than starting from scratch with a production bodyshell, Morgan pinned his base on an existing competition creation, the Beetle Fun Cup tubular spaceframe concept used in both single-make series and endurance racing. Acquiring a chassis was the easy part, together with the centre section of the composite bodywork, before setting about switching the powertrain.

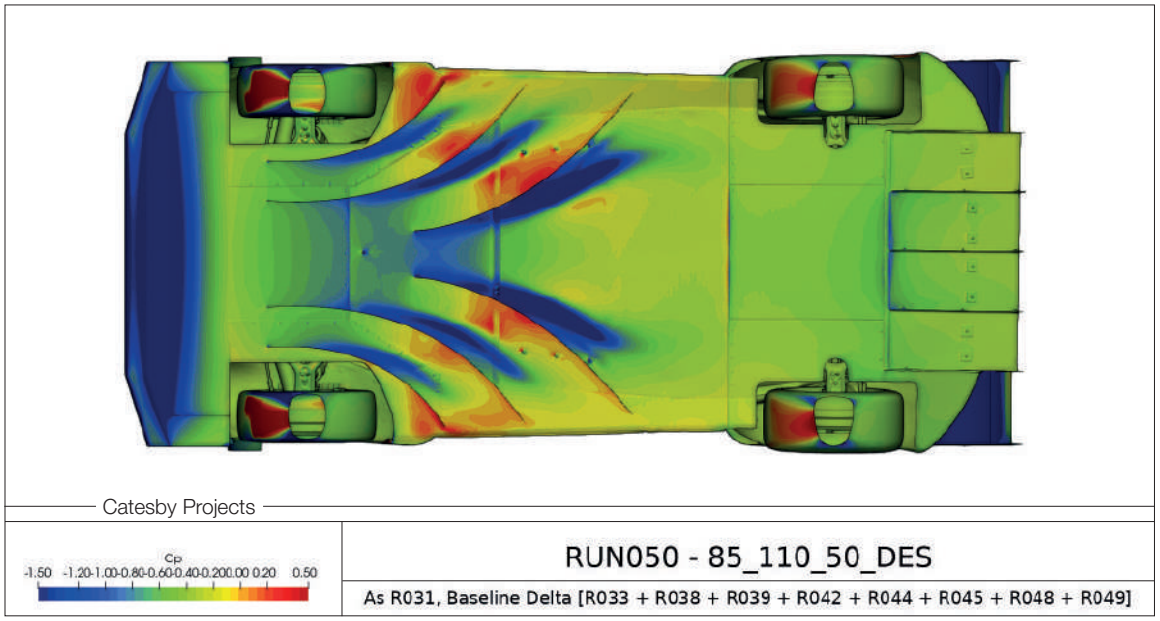
> *"As a crowd-pleaser, the Beetle was definitely right; as for everything else, it was probably the wrong way to go"*

"The chassis is designed for rear-wheel-drive with a five-cylinder Audi engine [rather than electric powertrain], but there's nothing like a challenge for ▶

BELOW BugZappa takes the finish in Colorado. Pikes Peak throws up unusual challenges – especially for a far from conventional car

Larry Chen Photo





LEFT & BELOW
LEFT The pressure coefficient (Cp) plots of the Baseline and Developed versions in CFD show the differences in pressure acting on the car. From the front to the rear, the splitter, floor strakes and rear wing generate significantly increased 'suction' pressure. These three components, in conjunction with a reduction in ride height, are where the most performance was extracted

an engineer to get their teeth into," says Morgan. "It was just a case of, like any other conversion we do, trying to figure out where everything's going to go. It's a packaging exercise. You start with the motors; they become the immovable objects and that determines where the battery boxes can go, the location of those then determines how the steering is going to work and so on.

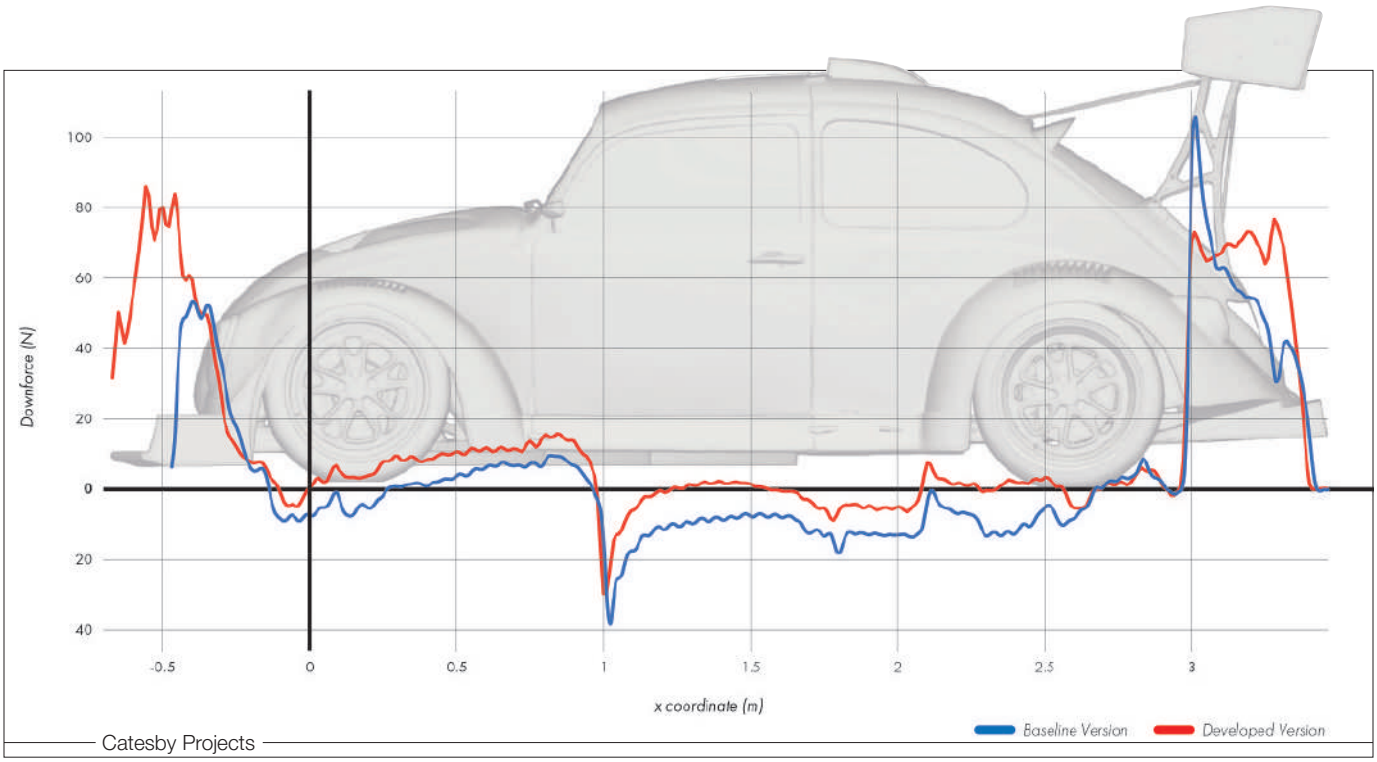
"The motors are the easiest bit because you can't put a motor anywhere else other than where the driveshafts need to meet it. One thing we did do on the rear motor is that we flipped it over on its back, because [in the Tesla production car] it usually hangs out the back like a Porsche 911 engine, which obviously isn't great for handling and polar moment of inertia. The rear motor then ended up in front of the axle [line], the same as we did on a Ferrari Testarossa, and other conversions."

More effort was required for the front motor packaging on the four-wheel-drive machine, as the Fun Cup chassis is only designed to usually house a rear drivetrain. As such, with the front motor in place, the geometry of the steering rack and steering column had to be adapted, to get over the motor.

Morgan's ECC outfit utilises motors from Tesla production machines for its multiple conversions. The BugZappa is no different, but the model of units used changed within the two-year build and development of the car, before heading to the US.

Proved a handful

"The ultimate goal is to put Tesla [Model S] Plaid in it, which is [the equivalent to] 1000 horsepower from the ultimate Tesla model they do," he says.



Catesby Projects

Catesby Projects

ABOVE Through a series of modifications, mainly the addition of a large front splitter and three pairs of underfloor strakes, Catesby Projects managed to not only shift the balance of the car to 41% but also increased the total downforce by 241%. The total drag acting on the vehicle has only been increased by 14%

LEFT Beetle meets Victorian railway tunnel: The team had already installed a large off-the-shelf wing, therefore one of the main goals was to generate enough front downforce to ensure the total aerodynamic load was evenly distributed

"But before we do that, I thought we should put in some motors that we're all familiar with here at the workshop and have plentiful supply of on the benches, so we went with the Tesla Model S Performance drive to start with.

"But, on track in testing, that proved to be quite a handful. It was a lot of torque and power for a small wheelbase, lightweight car like the Fun Cup. Even on the straights, all four wheels were spinning and you were just holding on. So we actually went back one step from that and put a Tesla Model 3 Performance setup in, which is a little bit less power [460 hp equivalent at peak] and a little bit less weight. The idea was to get the chassis and everything nailed so that it can cope with the Model 3 setup, then we'll step up."

> *"We definitely put lipstick on a pig as far as the aerodynamics were concerned"*

While the motors were a relatively straightforward packing exercise with fixed dimensions, the battery installation is much more flexible for ECC. That made for more head-scratching, because it has significant influence on chassis performance.

"You can treat batteries like ballast," notes Morgan. "You can't do that with fuel tanks because a fuel tank usually has to go in a certain place and there's only one. Batteries are different: you can actually put them wherever you need ▶

to get the optimal weight distribution. We corner weighted the car with the motors in, then worked on where to locate the batteries. The modules we use are around the size of a shoebox and we needed to find a home for 18 of those, so you are offering them around the chassis for optimal weight distribution and handling, but at the same time managing that with the seat, pedal box and so on; there are a number of constraints.

"There's also the electrical element, where you need to group the modules into groups of three because it's what's called a 3P6S system. That means three battery modules in parallel and six of those parallels in series, so we are constrained by having to keep them in those groups."

> *"Seven times more downforce than a production version of the car"*

Battery puzzle

BugZappa ended up with a battery box down either side of the Tillett driver's seat, with a third running transversally across the back of the seat.

Cooling for the battery packs and motors is naturally separate, although the cooling for the separate motors is linked. A pair of radiators are used in the car, made by AlliSport in the UK, with the front-mounted unit for cooling the battery system and the radiator fed by the air intake off the roof for the motors. ECC reported no thermal management issues "whatsoever" during its Pikes Peak assault, in part thanks to the efforts put into the machine's aerodynamics and cooling package.

Having ascertained that in standard form the Beetle had 180 kgs of lift at 100 mph, ECC enlisted Catesby Projects to undertake computational ▶

ABOVE & BELOW
Catesby Projects completed 3D scans of the car to provide a base for the aerodynamic development

Images: Catesby Projects

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fluid dynamics [CFD] analysis by 3D scanning the car to make changes and improve the external surfaces. Aerodynamics are significant for a Pikes Peak effort, with air density being a third less than normal towards the upper reaches of the course.

> *"We changed to a Subaru BRZ EPAS system which we found in a junkyard"*

Those conditions have a direct effect on both aerodynamic and cooling efficiency.

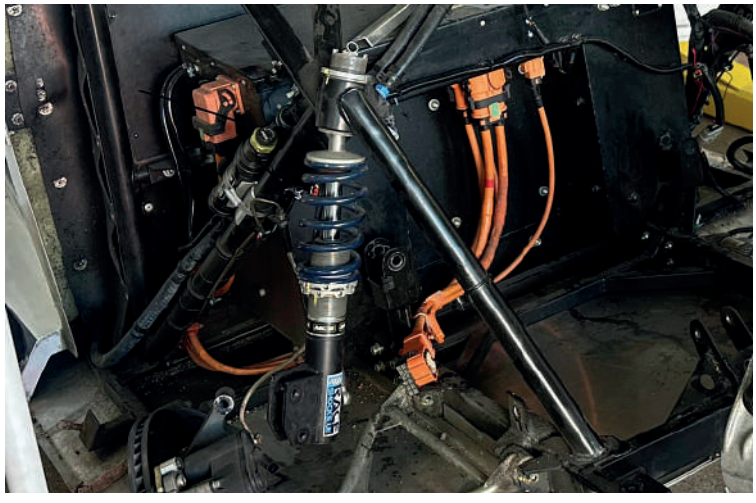
As part of the aero upgrades, a trio of rear wings accompany a rear diffuser. At the other end of the car, a front splitter is joined by gurneys on the front wings. Louvres on top of the wheel arches relieve positive pressure from inside the wheel houses and the windows have been moved as far out as possible in their surrounds to make as flat a surface down the sides of the car as possible.

More lipstick!

BugZappa is reported to have seven times more downforce than a production version of the car. In Morgan's words: "We definitely put lipstick on a pig as far as the aerodynamics were concerned."

Under the bodywork, BugZappa's chassis is very similar to its origins as a Fun Cup car, although the suspension and braking systems are different. A Fun Cup car is usually 860 kg, but with BugZappa weighing in at 1,400 kg, with more of the distribution to the front in the electric version too, new dampers were required. Race Shocks, based in South Wales, supplied bespoke three-way adjustable units for the car, using information and calculations supplied to them by ECC. Meanwhile, the Fun Cup's Golf MKII uprights, hub carriers and brakes were ditched in favour of slightly-modified Audi R8 uprights and AP Racing Pro 5000 R brake calipers. Bespoke heavy-duty driveshafts connect the four ▶

ABOVE The car is based on the Beetle Fun Cup tubular spaceframe concept



BELOW Race Shocks, based in South Wales, supplied bespoke three-way adjustable dampers

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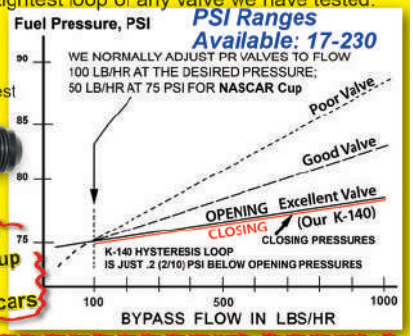

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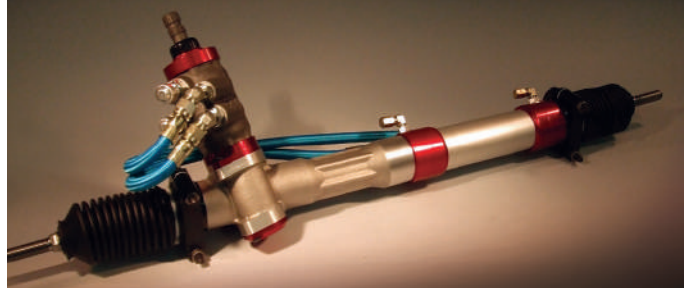

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LEFT The Colorado hills flash by on the shortened ascent

RIGHT AP Racing Pro 5000 R brake calipers are employed

BELOW The knock-on effects of the EV conversion threw up myriad challenges on a Fun Cup chassis originally designed to accommodate a rear drivetrain. The rear motor has ended up in front of the axle line. Battery boxes are located down either side of the driver's seat, with a third running across the back of the seat

driving wheels to the centrally-mounted motors.

Following the switch of motors during the development phase for the car, testing in the UK went well, and the ECC crew met its creation in Colorado for the start of Pikes Peak testing and preparation in the weeks leading up to the event. But, it's very difficult to simulate the kind of challenges the famous mountain poses.

> *"We had to do some major surgery in the last few days. But in your rookie year, a finish is a win"*

"I wanted to make sure the car was nailed and absolutely reliable, so we did a lot of testing at Oulton Park and different places to make sure that the car was good," says Morgan. "Unfortunately, Oulton Park is not Pikes Peak. We soon realised we had two main issues [from the start of running Stateside].

"Firstly, the power steering was struggling. You are loading up the suspension and the steering fully all the time at Pikes Peak and the steering motor was getting too hot. That was partially because we discovered we couldn't get the Michelin S5C+ tyre we had designed the car around in the US. We got hold of some Yokohamas, but the size they had was quite a bit wider on the front and that put additional stress then on the steering. We ended up with an air duct from the front to the motor, which worked really well, but it was still struggling. At the last minute, we changed to a Subaru BRZ EPAS [electric power assisted steering] system, which we found in a junkyard. The day before the race we went all the way down to Denver [for the parts] and had to rebuild the entire steering system from the steering wheel to the steering rack. A hot rod shop in Manitou Springs helped us and did a cracking job. That definitely improved it.

"The other problem we had was one of aggressive traction control management. If you floor the throttle [with BugZappa's electric powertrain], you've got maximum torque straight away – you have to be smooth!

"For our driver [Gregoire Blachon, Pikes Peak diesel record-holder], it was the first time he'd ever been in an EV, so he would lock up the fronts and then as soon as you come out of the [corner] apex, floor the throttle and light up the rears. The aggressive nature of the difference in rotational speeds between the front and rear axle was causing problems for our traction control system to keep up, and it would go into limp mode.

Front motor jettisoned

"I couldn't get him to change his driving style, so I just put it into rear-wheel-drive mode and we took the [80 kg] front motor out, and had to change the setup to compensate. So we had to do some major surgery in the last few days but we got it up the hill and a lot of people say that in your rookie year a finish is a win. So that's what I'm saying to myself."

BugZappa finished the event 54th overall and 15th in the unlimited class, but having made it so far, that isn't the end of the story. In part that is due to the problems encountered – a new steering system is already in the offing from DC Electronics – but it is also down to ill-fated weather: the 2025 Pikes Peak

event wasn't able to run over the full course.

Being an engineer and always seeking more potential, Morgan is keen to get the originally-intended Tesla Plaid system into the car, to see what they can do with increased performance too.

BugZappa will be back!

"There's definitely unfinished business," he smiles. "I really want to go to that ultimate level of ultimate performance, but that isn't just a case of a motor swap. We've also got to swap battery packs because we'll be changing from a maximum of 1,200 Amps to around 2,400 Amps and at the same time the voltage needs to be higher.

"I'm not going to go over there [again] without being absolutely 100% sure the car is perfect and nailed," he insists, "so I might see if we can enter into something like the UK Time Attack Championship. There's nothing like a championship to really refine a race car. We might have a break from Pikes Peak for a year, but we'll definitely be back." RT

"WE COULDN'T BELIEVE OUR WATCHES!"

In our second extract from 'Power Unleashed: Trailblazers Who Energised Engines…', **Karl Ludvigsen** takes the reader behind the scenes of the roller-coaster ride of supercharging, turbocharging and even more exotic power-boosting inventions. This time at the Indy 500

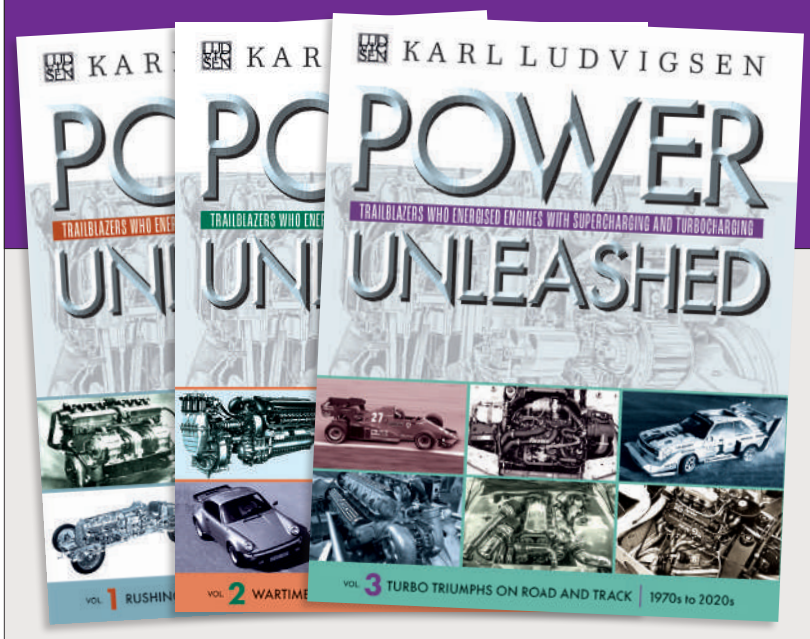
'IT had so much power we unquestionably will reduce the displacement advantage conceded...'

So often this sentence or one like it was heard by racing teams when sanctioning bodies decided that some were just too fast for their rivals. In the 21st century this was commonplace with 'balance of performance' options available to racing authorities who added poundage or constrained induction air to penalise performance that they deemed excessive.

Supercharging was affected by this mentality. This first occurred in 1938 when the international authorities allowed 4½ litres for unsupercharged cars while limiting blown ones to 3 litres. Later for lesser categories the FIA obliged supercharged cars to be rated as having 1.4 times their actual swept volume. When in 1966 3-litre cars ran unblown and blown ones were allowed 1½ litres, a window of opportunity opened for the latter that is one of the subjects of this chapter.

The sentence at this chapter's outset was uttered by Wilbur Shaw, three-time winner of the Indianapolis 500-mile race, when the yellow and orange number 28 Cummins Special completed its four qualifying laps for the 1952 running of the '500'. It had just shattered all qualifying records for this hallowed 2½-mile track.

Having done this with a diesel engine of 6.6 litres, the Cummins would race against cars of 4.5 litres unblown and 3.0 litres supercharged – hence Wilbur Shaw's remark. Even more sensationally, the colourful Cummins had been boosted by


KARL LUDVIGSEN
POWER
UNLEASHED
TRAILBLAZERS WHO ENERGISED ENGINES WITH SUPERCHARGING AND TURBOCHARGING
VOL 3 TURBO TRIUMPHS ON ROAD AND TRACK | 1970s to 2020s

POWER UNLEASHED: Trailblazers who energised engines with supercharging and turbocharging

Written by **Karl Ludvigsen**.
Published by Evro Publishing.
Price: £395. ISBN: 9781910505373

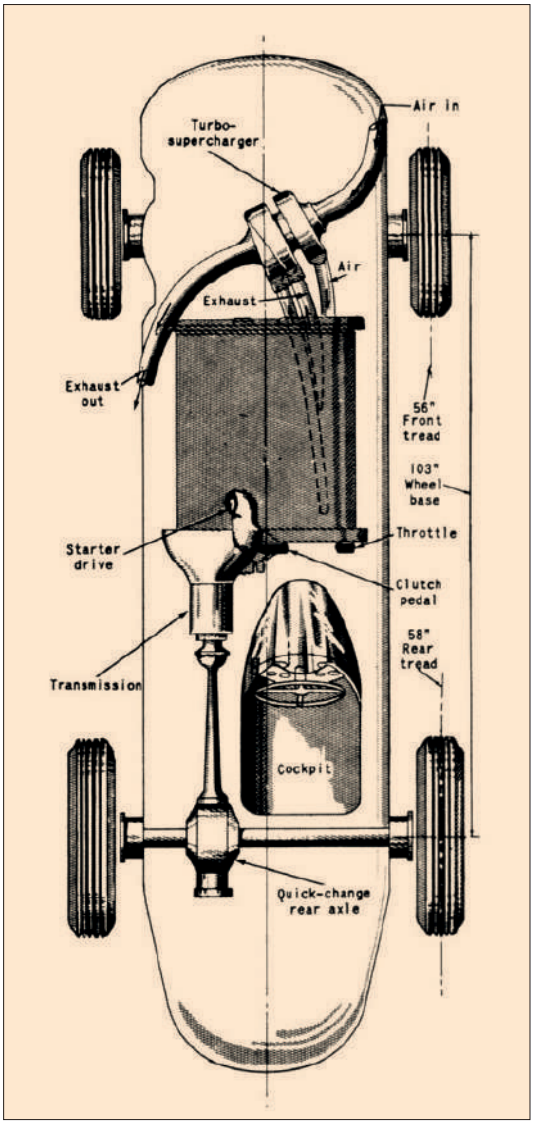
In a three-volume work of astonishing depth and detail, complete with reader-friendly technical descriptions and magnificent illustrations, Karl Ludvigsen introduces the fascinating individuals who bet their businesses on boosting

a turbocharger. This was the first time such a device had been used at the Speedway. Surprisingly in view of its effectiveness, 14 years would elapse before turbocharging would be tried again at Indianapolis.

With the Cummins Engine Company at Columbus, Ohio only 170 miles due east from Indianapolis, the famed maker of heavy-duty diesel engines had every reason to be interested in the opportunity the Speedway presented for demonstrations of the power and durability of its products. Company founder Clessie Cummins had done so in the 1930s, first with an exhibition run during the 500-mile race in 1931. In 1934 Cummins entered two cars to settle an in-house debate over the respective merits of two-stroke and four-stroke engines for diesels. The four-stroke prevailed – not in the race but in their decision.

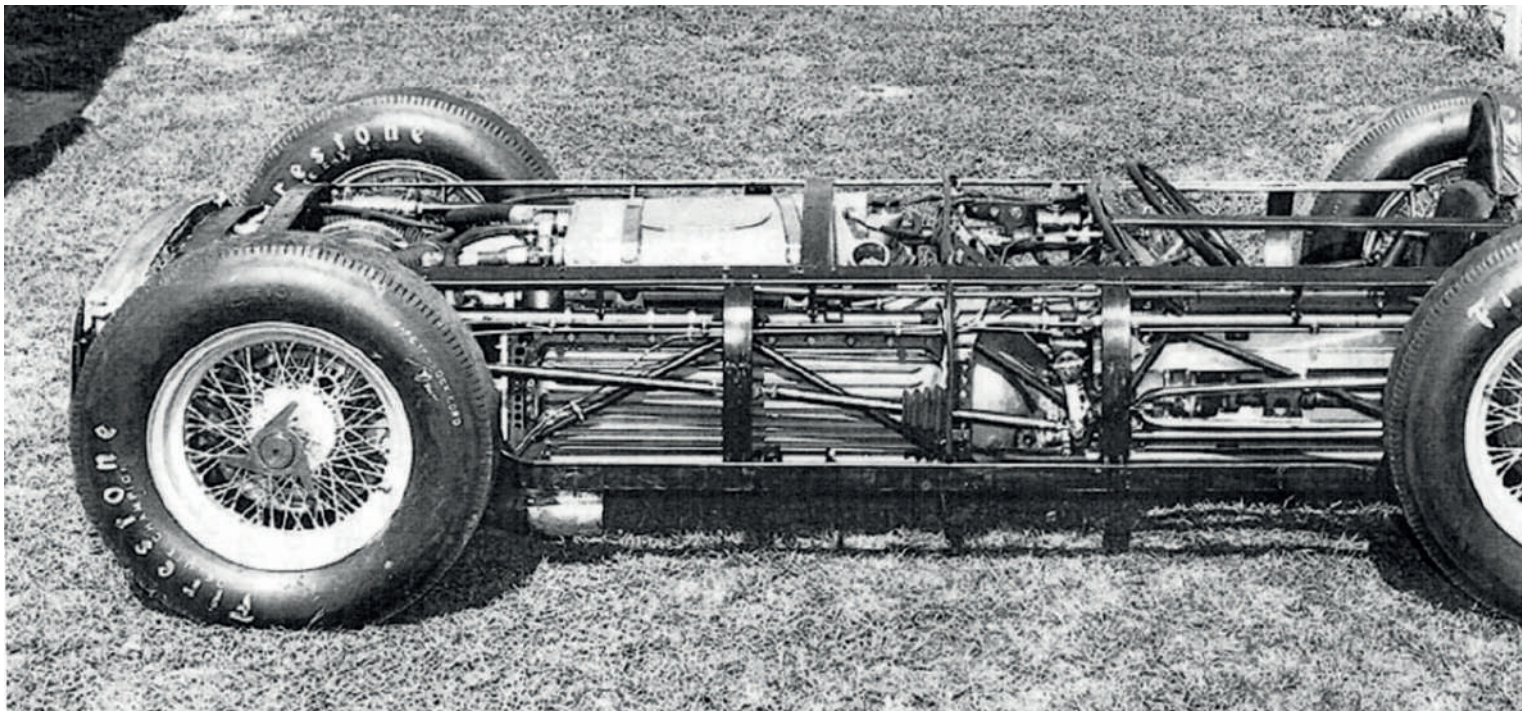
Clessie was nearing retirement when an opportunity arose to have a real crack at the 500-mile race, exploiting the diesel's ability to run the whole race on one tank of fuel to minimise pit-stop time. His son Donald aimed at 1950, when the Speedway opened entries for diesels of 402 cubic inches, with or without superchargers. A recent Cummins truck six, the model JS, had 401 cubic inches, approaching 6.6 litres. Perhaps not entirely coincidentally, this would do nicely.

Engineers Neville Melvin 'Nev' Reiners and Robert Charles Schmidt took on the task of creating the JSX version of the JS, which normally produced 150 bhp at 2,500 rpm. They achieved their aim of reaching 4,000 rpm with a swathe of improvements throughout the six, not least a new cylinder head with four pushrod-operated valves instead of two. The engine was ruthlessly lightened to 840 pounds from its original scaling of almost twice as much. An ▶



RIGHT A general indication of the Cummins Diesel racer's contents was given by the company. The position of the air entry to its turbocharger was to prove unfortunate on race day

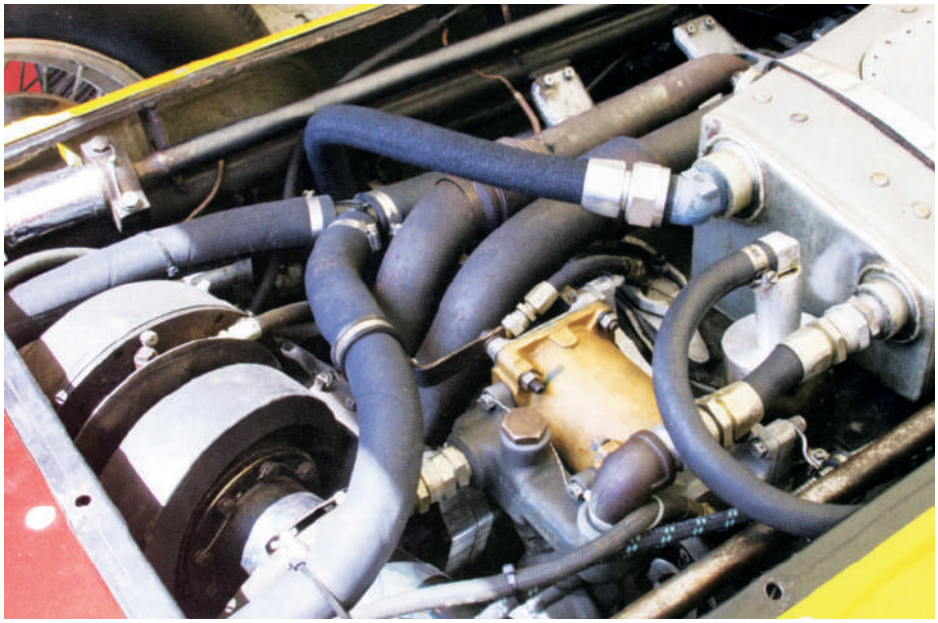
LEFT The Cummins colours were blazoned proudly on the company's racing car, here with its transparent bonnet for display after its adventures at Indianapolis, Indiana in 1952



experimental common-rail injection system with two nozzles per cylinder and a large Schwitzer-Cummins Roots blower instead of the normal small one helped reach 345 bhp at the hoped-for revolutions. Installed in a Kurtis chassis, this engine qualified at the back of the 1950 Indianapolis grid and retired two laps past quarter-distance with a failed compressor drive.

Undaunted, Don Cummins and Nev Reiners pressed on with a more ambitious programme, having the 1952 race in mind. An important constraint by Don was that the basic engine was to be entirely congruent with the production version, so that anything learned could benefit future Cummins engine buyers. A deviation in search of lightness was the assessment of major engine components cast of light metals. After dynamometer testing the final choice was magnesium for the crankcase and aluminium for the block and head. Nonetheless the six scaled 750 pounds and the complete car 3,090 pounds.

ABOVE Frank Kurtis and the Cummins engineers schemed the nearly flat positioning of their car's engine. Kurtis crafted a perfect space frame to cope with the racer's low lines

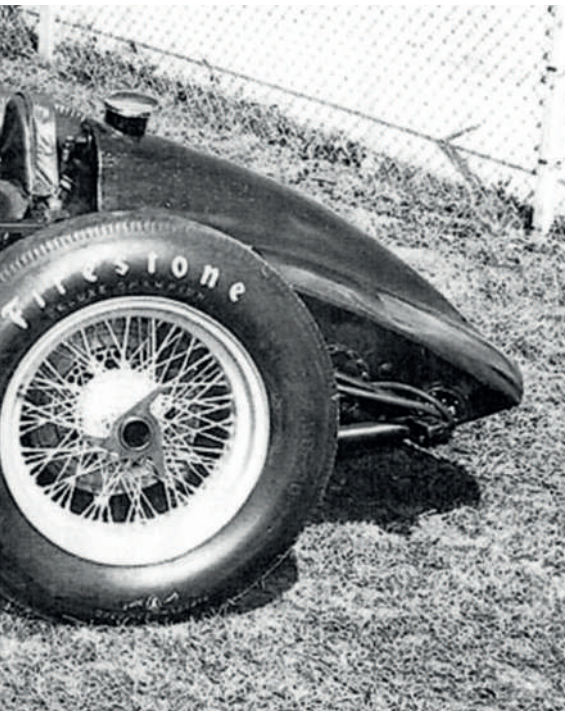


BELOW At the left the diesel engine's turbocharger is seen, a truck-rated product of Schwitzer-Cummins (no relation), while its oil filter and dry-sump reservoir are also visible

This time Cummins commissioned California's Frank Kurtis to build a bespoke racing car to take their big six. They gave him an engine mock-up that was inclined to the right within five degrees of horizontal, placing the propeller shaft along the car's left side and the driver on the right. This positioning of the drive line at 8¼ inches to the left of the centreline provided a 150-pound left-hand weight bias, a relatively new concept on the post-war Indy scene.

Around this machinery Kurtis fashioned the ultra-low racing car that he had long desired to create. He gave it a tubular space-frame chassis and independent front suspension. Torsion bars provided springing for all four wheels. It was said that without its headrest the car could have been run upside-down, substantially true with its low profile and huge 18-inch wire wheels. Final touches followed air-lifting of the engineless racer to Wichita, Kansas for tests in the university's full-scale wind tunnel.

Back at Columbus, Nev Reiners and W.D. Schwab were exploring the



potential of a compressor that would present fewer mechanical problems: an exhaust-driven turbocharger. Schwitzer-Cummins was again the source, providing a large turbo of a type already in use on heavy trucks. The hefty turbo sat at the right front, ahead of the Model-NHH engine, taking exhaust from its head's upper ports and delivering it to a manifold on the underside of the head. Its air supply was behind the same front grille that served the radiator.

Peak boost from the turbo was 1.4 bar, up from 1950's 1.0 bar, which gave 340 bhp at 4,000 rpm. Power rose in proportion to 430 bhp at 4,500 rpm. The state of the art at the time was that no wastegate was fitted, so acceleration of both engine and car would be an issue. At full throttle it took slightly more than 15 seconds from idle for the Schwitzer turbocharger to reach peak speed. Two engines were prepared for the race, one for practice and another, more powerful, for qualifying and the race.

Turbo lag

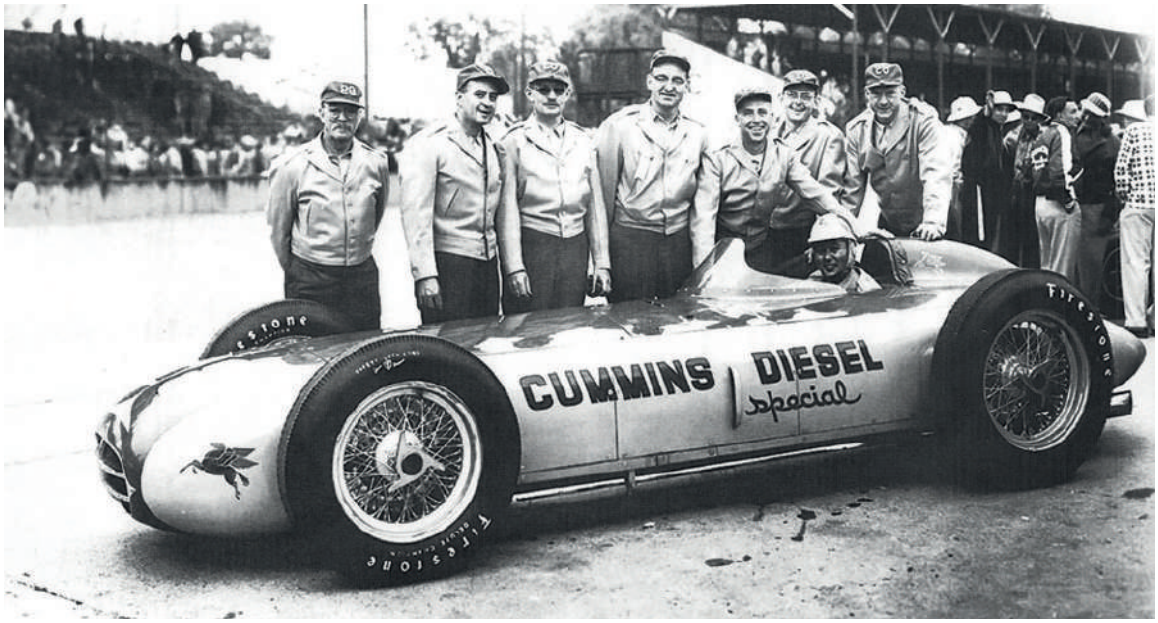
Fabrication of the new Cummins Diesel Special took place in the summer of 1951 and testing began that November. This revealed for the first time the famous 'turbo lag' of the vehicle. 'Acceleration off the turns was sluggish,' wrote author Roger Huntington. 'Boost was only 0.76 bar when the throttle was punched in the turn and it took three to five seconds for the turbine to speed up enough to give 1.0 to 1.4 bar down the straight.'

Nominated to race the Cummins was 38-year-old Fred Agabashian, a thinking driver from California. His first rides at the Speedway in 1947 and '48 were in the Ross Page Special, a pioneering low and offset Kurtis creation. Often tapped to test-drive cars, Agabashian had a mediocre record at the Speedway but was respected for his technical know-how. He also had strategic Speedway savvy, said Indy historian Donald Davidson: 'Fred knew they were going to upset the competition if they went there and started running fast right off the bat. They feared the officials might come along and change the rules.'

The turbocharged Cummins was noticeably quieter than the other 1952 entries, also noticeably smokier when it was started up, an operation that required the insertion of an electric starter in a special aperture in the car's cowl. 'So people couldn't figure out what Agabashian was doing,' added Davidson, 'he wouldn't go flat-out down the backstretch on one lap. He might cruise through one of the turns on another lap. For anybody that was timing from one point to another, they wouldn't see him do a complete lap at full speed because he wasn't showing it.' He told his team what they had: 'It's the best car I've ever had at the 500, and that's saying something.'

Practice times prophesied a historically fast field on 17 May, the first qualifying day. The first qualifier set a new record with four laps at 136.664 mph. This was raised to 137.002 mph by another Offenhauser-powered Kurtis Kraft. Among the last in the queue, just after 5:40 p.m., the Cummins Diesel Special began its qualifying run. Agabashian completed the first lap in 1:04.70 for an average speed of 139.104 mph. The next three laps went as follows: 136.206 mph, 137.931 mph and 136.820 mph.

Fred's first lap was a single-lap Indianapolis 500 record. The four-lap timing of 4:20.85 produced a four-lap record of 138.010 mph. 'We couldn't believe our watches,' said developer and crew chief Nev Reiners. 'We clocked him at 139.014 mph with three watches on the ▶



RIGHT With pole position for the 1952 500-mile race wrapped up, Fred Agabashian and the ecstatic crew from Columbus could relax to say 'cheese' for the official photographer

RIGHT A smoky start during practice wasn't unusual for the Cummins Diesel Special. But the design of its turbo impeller contributed to its 177-mile pit stop and early retirement

LEFT The Cummins Diesel Special set new standards in racing-car design and the use of turbocharging. But some years would pass before its lessons were taken on board

first lap but we just couldn't believe the car had gone that fast.' Neither could anyone else, including Wilbur Shaw, who said, 'The Cummins diesel, along with Fred and members of his crew, have accomplished a feat in the automotive experimental field never before equalled in the history of the Speedway.'

By 5:45 pm Fred had rolled the car into the pits. In later qualifying two cars would surpass its speeds, but too late to deny it pole position. Noticeable with full acceleration were light-grey smoke plumes testifying to a full-performance injection setting. Thanks to the car's weight, 3,480 pounds plus Fred and enough Number 2 diesel oil to qualify, it had been brutal on tyres. When it pulled into the pits the two right tyres were nearly in shreds.

For the race neither crew nor driver was particularly concerned about the tyres. Their plan was to make one stop for a fresh set. The car had a 50-gallon tank and averaged 10 to 12 miles per gallon so it could cover 500 miles without refuelling. Because of the need to change tyres, Cummins planned to start the race with enough fuel for 80 laps and pit for tyres and fuel then.

In front of 5,000 Cummins employees bused in from Columbus, the start of the race on 30 May 1952 was ragged behind an overly slow pace car, which did not suit the Cummins Diesel Special. It fell to eighth into the first turn and ninth at the end of the first lap. After 25 miles the orange and yellow Cummins moved up to sixth, running at 129 mph versus the leader's 130. At 50 miles it was fifth, running faster than the 1951 record winning speed, and held that position through 100 miles. At 46 laps – earlier than planned – Agabashian pitted for a minute for two new tyres.

Agabashian pressed on but on lap 71, after 177 miles, his car began to smoke heavily, so he pulled into his pit. Inspection showed that dirt and rubber from the track were clogging the impeller blades of the engine's turbocharger. Any tendency for this to occur was amplified with the Schwitzer unit, whose impeller was shrouded. Not having anticipated this problem, the team had made no effort to raise the height of the air inlet. Debris choked the air supply and richened the mixture, causing the smoke. Though the car was still raceable, the crew felt it would probably be flagged off so they retired it at that point.

As a racing performance this had not been convincing – certainly not enough so to warrant the diesel-engine capacity cutback that the Speedway implemented for 1954: a reduction from 402 cubic inches to 335, 5.5 litres. The world's motor industry was hardly bursting with companies both able and willing to build racing diesel engines. Another would not come along until the 21st century.

As an introduction of the turbocharger to the world of racing, the Cummins was no less than sensational. It had far more impact that its lonely predecessor, the 'disappointing' Halford Special of 1925. But that impact was slow to make a mark on motorsport. Turbocharging would eventually have its day at – of all places – the heart of the American Midwest, Indianapolis.

As related in Chapter 9, for the 1966 season of Indy-Car racing Dale Drake, his son John and Leo Goossen designed and built a new version of the veteran Offenhauser four expressly for supercharged operation. Ford's introduction of a four-camshaft

RIGHT The Cummins creation was let off the leash for spectators at England's Goodwood. While onlookers were impressed, few were aware that it was a turbo-racing pioneer

version of its racing V8 swung Speedway supremacy steeply toward the auto maker. The Offy was seen as yesterday's engine. But it had its supporters, not least sparking-plug maker Champion, whose business was threatened by Ford's Autolite plugs.

Based on the architecture of Drake's '220' four, also used in many applications in 3.0-litre form, the engine was de-stroked and lowered for Champion to the required 2.75 litres and given a 9.0:1 compression ratio. The first such engine was unveiled to the racing fraternity on 22 October 1965. They were snapped up by teams that had enjoyed success at the Speedway and elsewhere with their Roots-supercharged Offy fours.

Creation of this rugged new engine, with radically shorter connecting rods and cylinder block and well oversquare for 2,738 cc, occurred in parallel with another approach to the blower solution. Robert 'Bob' DeBisschop, in the research arm of Garrett AiResearch, proposed the use of an exhaust-driven turbo-supercharger. Without his initiative, and the resources that Garrett subsequently brought to the project, the transition to turbos for racing cars may have been even more protracted.

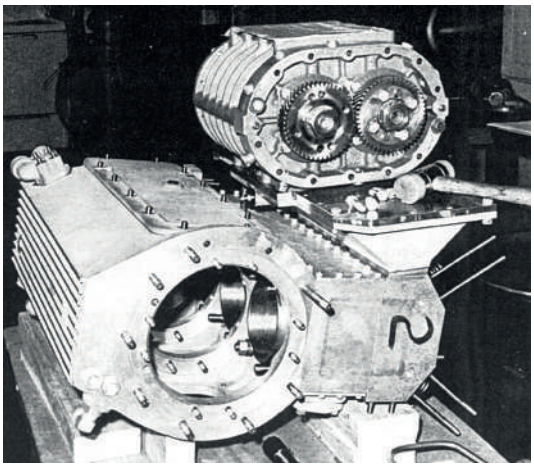
A racing-mad engineer, the tall DeBisschop had worked for Frank Kurtis before a spell with McCulloch, where he adapted its chainsaw engine as a go-kart powerplant. He built racing roadsters for California's short-track hot-shots, which led to his first stint at the Indy Speedway in 1955, followed by many crew assignments on competitive Indy-car teams, up to and including building complete cars. Then at AiResearch he worked on the Oldsmobile Jetfire turbo and applications of turbochargers to aircraft. The idea of a turbocharger on an Indy car was manna from heaven for Bob DeBisschop.

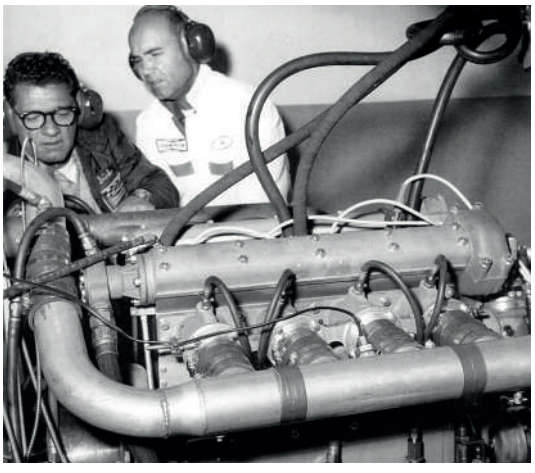
Dyno thrashing

Stuart Hilborn of fuel-injection fame helped DeBisschop work out the piping to adapt a suitable turbocharger to the 2.7-litre Offy. The Garrett man's first choice as partner in the venture, famed car builder Abraham Joseph 'A.J.' Watson, passed on the project. DeBisschop then turned to Goodyear-tyre ally Champion Spark Plug, which had an engine-test facility at Long Beach.

Operated by Richard 'Dick' Jones and assisted by Art Lamey, the Champion dynamometer endured a thrashing as they found that the turbo-blown engine produced 626 bhp at 8,500 rpm, against 530 bhp for the Roots version at the same speed. In fact the turbo-blown engine's power curve was a direct extension upward of the output of the blown Offenhauser of 1954. They both produced 500 bhp at 6,500 rpm but there the Roots-charged engine peaked. The turbocharged version ultimately ran safely to 9,500 rpm, a remarkable figure that testified to the skills of Dale and John Drake and their engineer Leo Goossen.

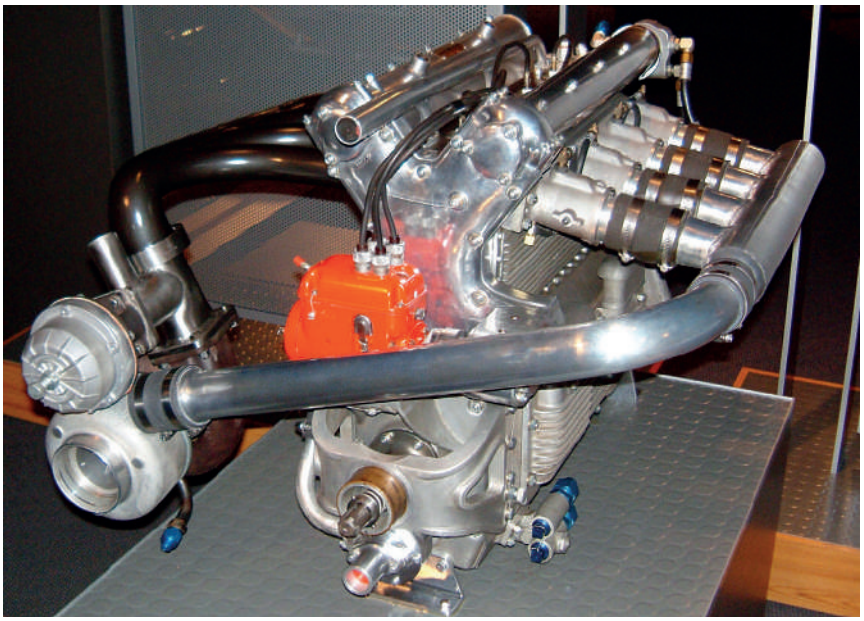
An important link between theory and practice was Herbert 'Herb' Porter, whom we met in Chapter 9. His decades of experience with blown racing engines equipped him to engineer the turbo's transition from dynamometer to racetrack. Ebb Rose made available his obsolete Watson-built front-engined 'roadster' in which Porter installed the turbo-Offy, its turbo and pipework hanging outside the body on the left. The unit used was a type that Garrett supplied ▶





FAR LEFT This was the state of the Roots-blown Offenhauser when AiResearch's Bob DeBisschop suggested to Drake Engineering that it consider using a turbocharger

LEFT Dick Jones, left, and Art Lamey ran the dynamometer on which the turbocharged Offenhauser was developed. They convinced Stuart Hilborn to create its fuel injection



to Allis-Chalmers for its diesel-powered tractors.

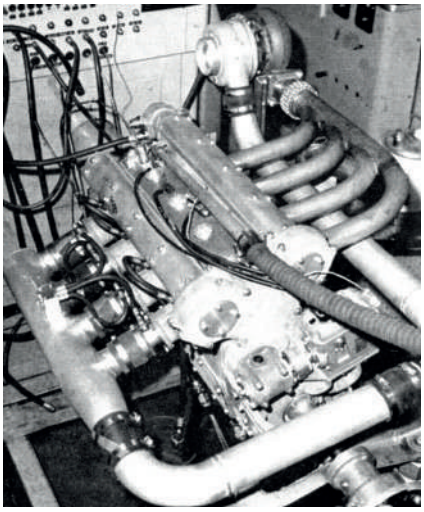
The venue for its first trial was a test session of Goodyear racing tyres in April 1966 at Arizona's recently built mile-long Phoenix Raceway. 'After Porter had warmed up the car,' wrote Offy expert Gordon Eliot White, 'A.J. Foyt took it out, but a puzzled A.J. quickly shut down and coasted back into the pits. The engine had popped and sputtered – A.J. thought it had blown something. Porter looked it over and found nothing wrong. Foyt went out again. After going fast enough for the turbo boost to become effective, the engine ran well enough to be encouraging.'

After Foyt left to attend to other matters, White added, 'Porter hired Don Branson to drive the roadster. By the end of four days the sputtering in the turbo transition stage was eliminated. Goodyear's tyre session had proved that given unlimited boost, the turbo Offy could beat the four-cam Fords. With encouragement from Goodyear Racing Director Leo Mehl and Foyt, Goodyear continued to help fund the Offy's development.

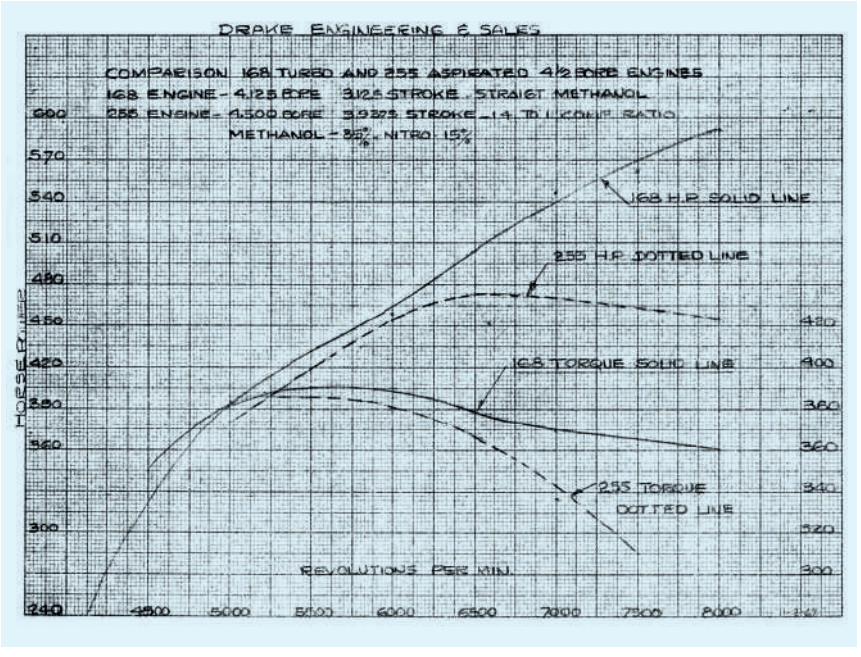
'The company put Porter on its payroll as the engine man for tyre testing,' White said, 'and bought him a half-dozen turbo Offys for the job.' These were to the final design with cylinder blocks of aluminium rather than iron to dissipate the heat generated by higher power. Although steel-sleeved, the new blocks required laborious efforts by Drake to produce reliable parts. Not until 1968 was this fully achieved for engines suitable for the 500-mile race.

ABOVE This earlier-specification 2.7-litre Drake Offenhauser was loaned to the turbocharging experimenters by Vince Conze. It wears an AiResearch turbocharger and wastegate

RIGHT On Champion Spark Plug's dynamometer in 1966 the fuel-injected Offy four wore a turbo of a type used by diesel tractors. It soon revealed a pleasing penchant for power



BELOW As drawn by Drake engineer Leo Goossen, on 15 per cent nitromethane and 85 per cent methanol plus 14:1 compression ratio the turbo-fed four far outpowered its rival



Herb Porter entered the turbo-Offy Watson for the 1966 Indianapolis race chiefly as a test exercise, its driver the veteran Bobby Grim. 'Grim qualified at 158.367 mph,' Gordon White related, 'and turned a practice lap at more than 160 mph, the fastest a roadster ever ran at the Speedway. At the start, with only a two-speed gearbox the car was unable to accelerate as rapidly as the more modern four-speed Lolas and Lotuses. When another car spun Grim was unable to avoid it. His race ended after 750 feet in a first-lap wreck that eliminated Foyt, Gurney and eight other cars before they reached the first turn.

'During practice,' said White, 'for the three steel-sleeved, aluminium-block turbos there were problems of expansion-rate differences in the blocks, ▶

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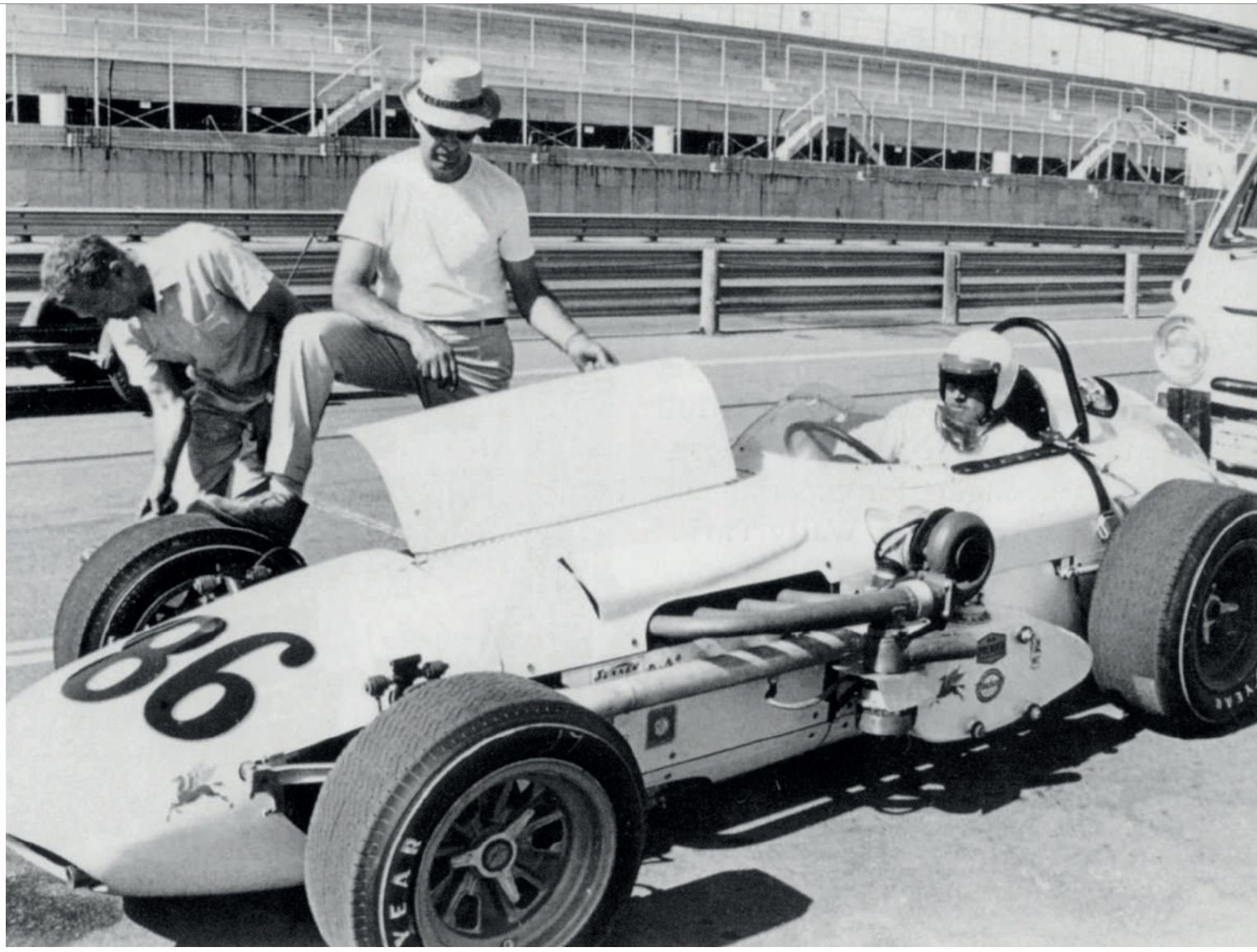


sleeves and valve seats. Bobby Unser blew turbo engines in his rear-engined Huffaker more than a dozen times but would finish eighth. Turbo lag was a continual problem. A typical remark by a driver sampling a turbo-Offy was, 'It's the first engine I can't drive full-bore off the corners.'

Fed by an AiResearch T-06 turbocharger, in 1966 the Offy produced 625 bhp at 8,000 rpm. In 1967 seven of the eight qualifying blown Offys were turbocharged units, with Chuck Hulse and Art Pollard placing seventh and eighth at the finish. Of the 33 qualifiers for the 1968 race, 15 were turbocharged Offys. Among the 11 still running at the finish nine were turbo-Offys. This included the winning car.

Herb Porter – now widely known as 'Herbie Horsepower' – and crew chief Jud Phillips prepared the Rislone-sponsored Leader Card Eagle of Bobby Unser for the 1968 Indy 500. This was a mid-engined car, not unlike the previously successful Lotuses. A transition at AiResearch akin to that in aviation was a change for 1968 from Haynes stellite to Inconel for the turbine material. They tuned its turbo-Offy to produce 625 bhp for qualifying and a fuel-saving 590 bhp for the race. Unser qualified among the fastest entries at 169.507 mph, monopolised the lap-leading prizes and won at an average speed of 152.882 mph in front of a 300,000-strong crowd. Driver and team shared the winner's $712,269.

No small amount of development

BELOW In a front-engined Watson with Offy four and outboard turbo Bobby Grim ran Indy laps at up to 160 mph in 1966, the fastest timings an outdated 'roadster' had recorded

LEFT Herb Porter looked on when A.J. Foyt tried a Watson 'roadster' equipped with an outboard turbo at Phoenix Raceway in April 1966. It soon showed race-winning pace

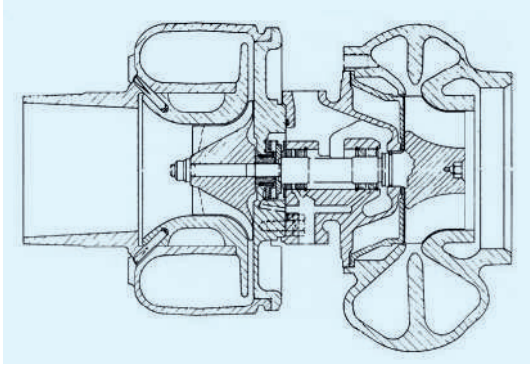
RIGHT Bob DeBisschop and AiResearch were pressed to bring bigger turbos to the party, starting from this TE-06 with a divided turbine entry to ensure efficient delivery

BELOW In a new turbo-Offy All American Racers Eagle designed by Briton Tony Southgate, Bobby Unser led Indy for 127 laps of the 200 in 1968, including the last nine for the first turbo victory

had been needed to get the engine to the point where it could win. At first it overheated severely. Larger water-duct sizes helped. Later the block was redesigned to ease the heat intensity on the exhaust side. For the first time the block was made asymmetrical to add more water capacity around the exhaust ports, which were divided into two ports with a small water passage between them. Special internal pipes sprayed cool incoming water into this passage and on the inner surface of the exhaust-valve seat area.

A nagging problem with the blown Offy caused Lloyd Ruby's retirement after only three laps at Indianapolis in 1967. Although the turbocharger was relatively small it still had ample inertia when spinning at its 85,000 rpm peak. When a driver declutched to make a full-throttle upshift the engine tended to keep revving higher, sometimes past the danger point. That happened to Ruby's top-qualified Offy that year at the Speedway. Drake and Hilborn tried three different systems to lick this fault, which made the turbo-Offy nearly unusable on a road course.

Shrewd development smoothed out the engine's torque curve, filling in a former low point at 6,000 rpm. The Drakes concentrated on strengthening the engine to stand up to crew chiefs who were not satisfied with supercharging to 2.7 bar on top of an 8.5:1 compression ratio, adding to that five to ten



per cent of nitromethane. An increase in the radii of the crankshaft journals' join to the cheeks made them virtually unbreakable. Magnetos gave way to Mallory distributors.

To shrink their Offenhausers to 159.4 cubic inches to meet new 1969 rules, Drake Engineering made sets of sleeves which when pressed in, with a 0.006 inch interference fit, brought the bore down to 4.030 inches. When these were installed in an old block they naturally created slight combustion-chamber overhang around the edges. New 1969 blocks had a reduced chamber diameter to eliminate this.

Seeking better mid-range power, Stuart Hilborn reverted to testing the latest Offy engine in unblown form. This led to ram pipes that were both longer and larger in diameter. RT

MOTORSPORT *IS* DANGEROUS

Nobody wants a return to the 'bad old days' but has modern motor racing become too sanitized? **Sergio Rinland** grabs the nettle…

ERNEST Hemingway famously said: "There are only three sports: bullfighting, motor racing, and mountaineering; all the rest are merely games".

It was a reflection of his belief that true sport involves mortal risk. To him, these three disciplines stood apart because they demanded not just skill and endurance, but a confrontation with death itself. Are we nearing the age when motorsport, and more specifically Formula 1, is becoming a mere game and no longer a sport (in Hemingway's definition)?

After the delayed start of this years' Belgian GP at Spa due to rain conditions, journalist Claudio Maglieri wrote a piece in the Italian press which got me thinking.

His critical view is that the sport, once a heady mix of glory, danger, and unfiltered human drama, now feels anaesthetized. Everything flows in a haze of politeness and "let's all get along," where swearing is frowned upon, where wet-weather tyres gather dust, and where excitement too often depends on DRS overtakes.

Of course, safety has improved immeasurably over the decades, and rightly so thanks to the efforts of Sir Jackie Stewart, Professor Sid Watkins, Peter Wright, Charlie Whiting and many others. Nobody wants a return to the tragic days of the past, when drivers, mechanics, marshals, and even spectators too often paid the ultimate price. Back then, risk was accepted, even respected. Drivers strapped themselves into their machines knowing that triumph and tragedy lived side by side, and fans accepted that danger was inseparable from the spectacle.

Has the pendulum swung too far? Motorsport is dangerous, by definition. No amount of regulation can change that. Today, we seem intent on protecting drivers from themselves, as if they were reckless children. I was yelling at my TV set during the most recent Belgian GP "rain delay" as the track dried before our eyes. It reminded me of Spa 2021, when the Grand Prix was suspended in farcical fashion. Disgraceful. Drivers know when to lift, when to slow down, when to push. Racing is about judgement and courage, and victory often belongs to those who risk the most, as Oscar Piastri proved at Eau Rouge, especially when you don't have a car advantage over your rival.

Eau Rouge is still dangerous, even if the extended run-offs 'forgive' a driver's errors, it is still blind to an accident further up. Some have now even suggested inserting a chicane there, a thought so absurd it borders on sacrilege. Do you remember Siffert and Rodriguez entering Eau Rouge side by side with the Porsche 917s in the 1970 1000Km?

"Tell Pedro it's raining"

Or Rodriguez at Brands Hatch, when Jackie Oliver said to John Wyer: "Someone tell Pedro it's raining!"? (He took five laps off Elford/Hulme who finished second in another 917!) Poor Pedro died months later, not because of the rain, but due to a mechanical failure, a reminder that danger in racing comes in many forms and can never be eliminated entirely.

Claudio Maglieri also has a point when he says that race officials, in their attempt to inject drama that would otherwise be missing, come up with all sorts of gimmicks and often incomprehensible penalties. Then chaos ensues and the blame falls on the circuit. Yet races are held in Baku and Jeddah, and no one questions the dangers of two ultra-fast street tracks.

We are too easily dismissed as nostalgic, accused of wishing for "the bad old days" when death stalked every weekend. Nothing could be further from the truth. No one wants tragedy. But in chasing absolute safety, Formula 1 risks losing the very essence that made it compelling: the courage to confront danger, the awe of watching individuals pit themselves against fear and becoming true heroes. Just as 'F1: The Movie' showed us on the silver screen. RT

Newspress

BELOW Siffert and Rodriguez banging wheels going into Eau Rouge: no gimmicks, just guts

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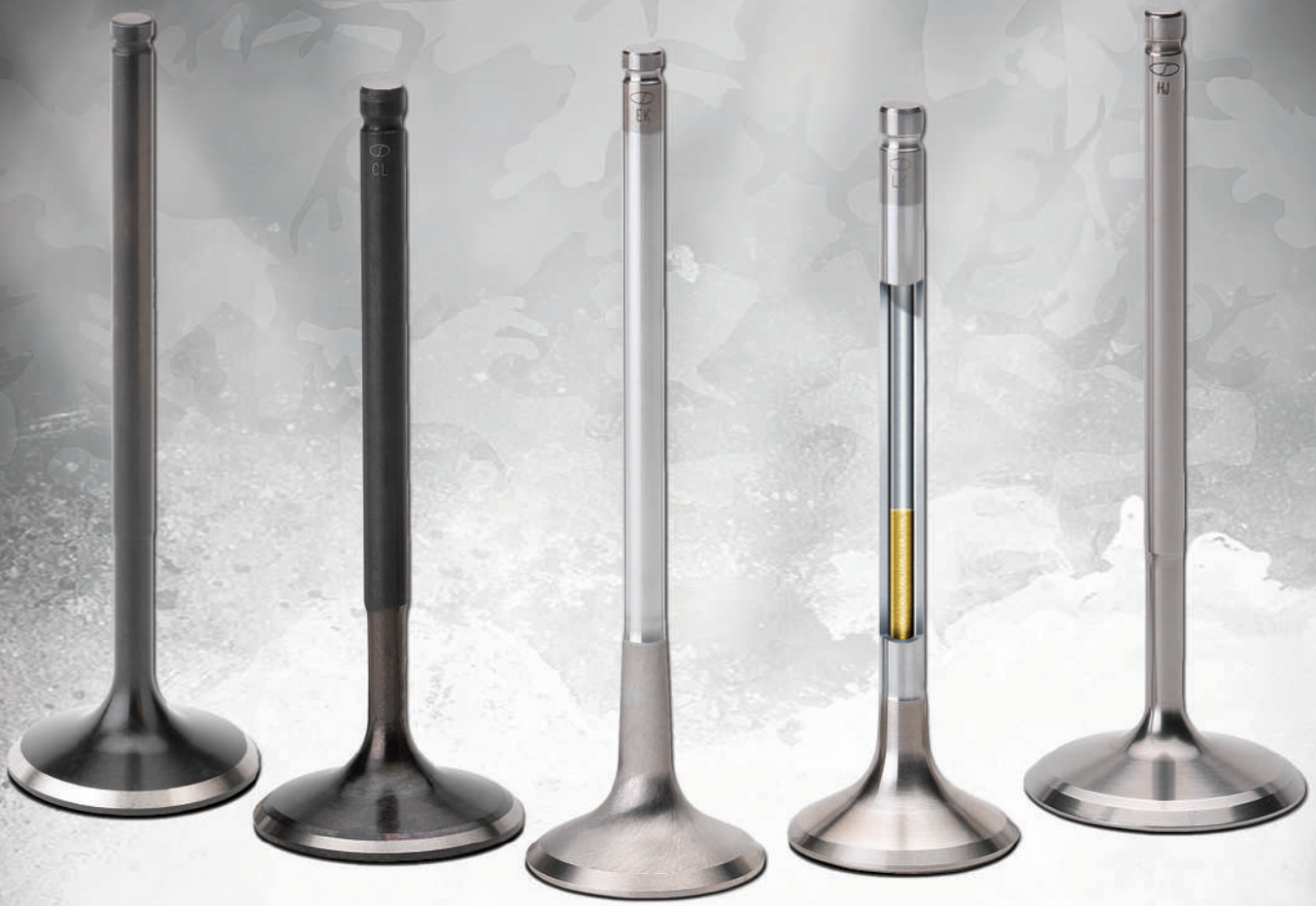

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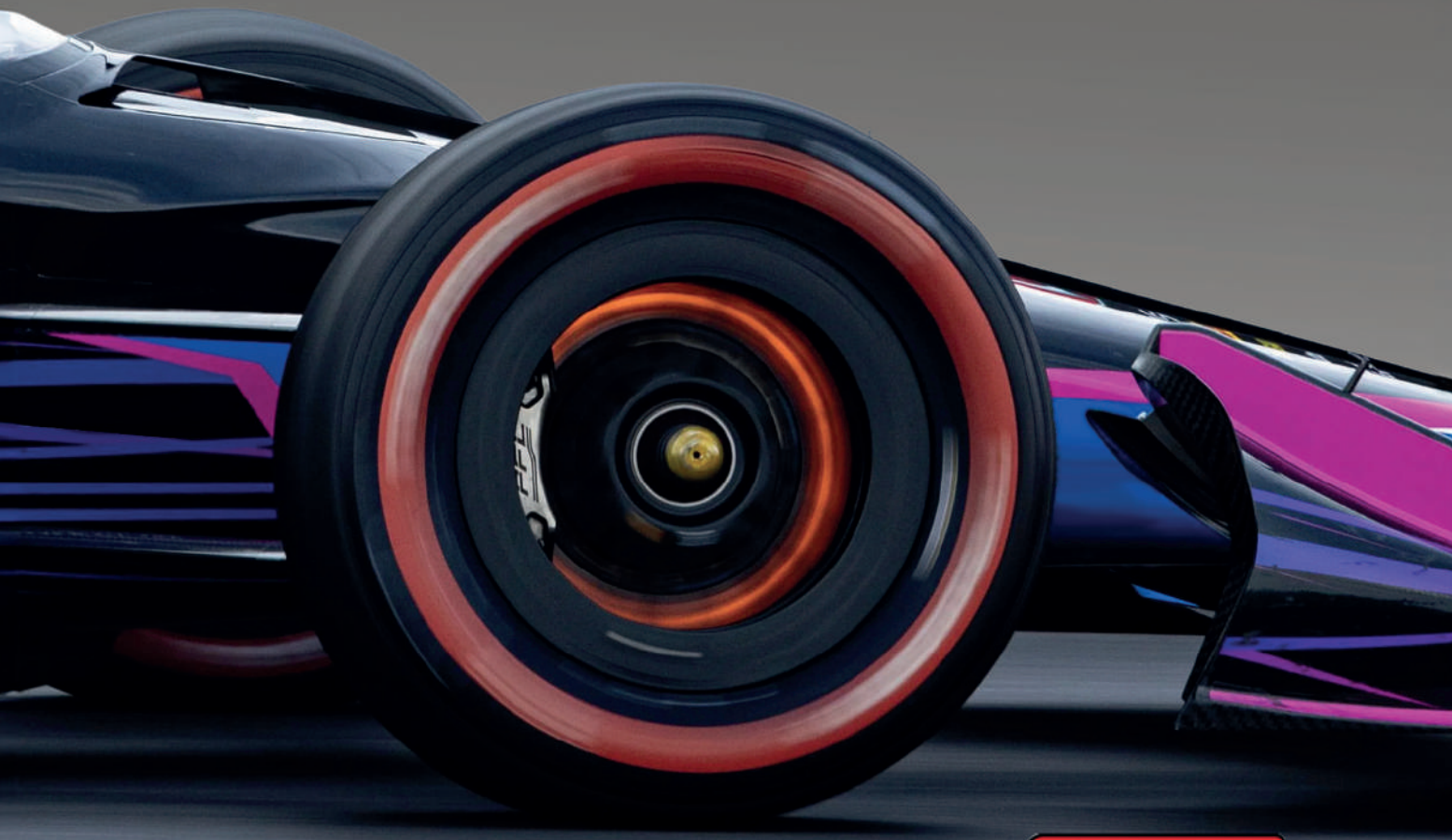

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